LONDON-WEST MIDLANDS ENVIRONMENTAL STATEMENT

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Transport Assessment (TR-001-000)

Annex C: Model performance reports

Traffic and transport

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Annex C - Model Performance Reports

This Annex contains the following model performance reports, working papers and technical notes:

- Railplan Model Performance Report - Annex C(i)
- CLoHAM Model Performance Report - Annex C(ii)
- WeLHAM Model Performance Report - Annex C(iii)
- Euston Road (Region 8) TRANSYT Modelling Working Paper - Annex C(iv)
- Old Oak Common Local Area TRANSYT Model Technical Note - Annex C(v)
- West Midlands - Model Performance Reports - Annex C(vi)
    - Birmingham Interchange SATURN Model Performance Technical Note
    - Birmingham Interchange VISSIM Model Performance Report
    - Birmingham City Centre SATURN Model Logic Check Technical Note

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Annex C(i) – Railplan Model Performance Report

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1 Introduction

1.1.1 Regional Railplan is a strategic public transport assignment model now developed and managed by Transport for London (TfL). It was initially developed by London Transport in the early 1990s.

1.1.2 Historically, Railplan has been primarily used for the morning peak period (07:00 to 10:00) on an 'average' Monday to Friday weekday in a neutral month. However, inter-peak and evening peak versions have also been developed although these are used less frequently. For the assessment of HS2, TfL and HS2 Ltd agreed that the AM peak period and PM peak period models should be used. TfL are planning to undertake inter-peak period model runs to assess HS2 but these have yet to be undertaken and are not therefore covered in this report.

1.1.3 The model contains the service patterns for public transport modes within the South East of England, with a focus on London and for rail routes serving London during the modelled periods.

1.1.4 Railplan is calibrated to a 2007[1] base year and has future years of 2011, 2016, 2021, 2026 and 2031; a 2041 forecast was developed by TfL for the HS2 project. The public transport demand, derived from LTS (the London Transportation Studies model - a strategic multi-modal land-use transport model for the London region), is assigned to the optimal routes in the network, being a combination of rail, underground, light rail or bus usage, together with walk for shorter journeys as well as for interchange.

1.1.5 Following the scoping and initial Transport Assessment (TA) work for the HS2 proposals, it was agreed by HS2 and TfL that Railplan, with appropriate feeds for long distance rail demand from the DfT's PLANET model, was the most appropriate model for assessing the public transport effects of the HS2 proposals within London. It was also agreed that TfL itself would develop the future baseline and future baseline plus operation (i.e. with HS2) scenarios. The assumptions underlying the testing, details of the coding of HS2 options and model results have been discussed at regular bi-weekly meetings involving TfL, HS2 Ltd and HS2's consultants for Euston and London Metropolitan. TfL have incorporated feedback from this review process which have been included in revised Railplan runs for the base and future years.

1.1.6 This Model Performance Report is primarily focussed on the 2007 base year model but also covers details of the future year modelling and has been produced by HS2's consultants for Euston and London Metropolitan.

[1] TfL has advised that it is rebasing the Railplan model to 2011, but this work will not be complete until early 2014.

2 Guidance on public transport model validation

2.1.1 Guidance on the validation of public transport models is limited. The most useful guidance is contained within DfT WebTAG (Unit 3.11.12) which states, with regard to the validation public transport assignment models:

"10.1.5 Validation of the assignment should involve comparing modelled and observed:

- *passenger flows across screenlines and cordons, usually by public transport mode and sometimes at the level of individual bus or train services; and*
- *passengers boarding and alighting in urban centres.*

10.1.6 Across modelled screenlines, modelled flows should, in total, be within 15% of the observed values. On individual links in the network, modelled flows should be within 25% of the counts, except where observed flows are particularly low (less than 150)."

3 Railplan model validation

3.1.1 The Railplan model for 2007 was validated by TfL at a strategic level and is documented in a Technical Note entitled 'Regional Railplan Validation', prepared by TfL Planning (Policy Analysis) and dated October 2011.

3.1.2 The following is extracted from the conclusions of the TfL Technical Note:

"TfL believe that Regional Railplan is fit for purpose for sub region/London wide level studies but for more localised studies it is recommended that users review flows, boarders and alighters and general validation statistics/performance prior to undertaking work. It may be necessary to make localised adjustments to the model to get the most out of it at a localised level."

3.1.3 There is no reference to validation against the WebTAG guidance in the TfL validation.

3.1.4 In accordance with the recommendation by TfL for the HS2 TA, additional local review and general validation of the model has been undertaken at Euston station, for the AM and PM peak periods, and is summarised in this report.

3.1.5 It should be noted that there is limited contemporaneous count information available for the local validation of a 2007 based model.

3.1.6 The Railplan model for 2007 was validated in 2011 including National Rail (NR) data for flows at Euston station. This indicated NR trips arriving at Euston between 07:00 and 10:00 in Railplan of 17,230 compared with 2007 observed NR data of 17,120, an extremely good validation. However, during the course of the project it was discovered that the 2007 data for NR trips on the corridor to/from Euston was 'out of line' with data for other years including 2006, with the 2007 data appearing relatively low. The implication of this is that a significant proportion of forecast Railplan growth in NR trips on the corridor to/from Euston between 2007 and 2026 had actually occurred by 2012. Accordingly, morning peak arrivals and evening peak departures in

future year forecasts have been adjusted. This demand adjustment potentially relates both to a correction in the base year and reflection of higher than otherwise forecast growth to 2011.

3.2 Headline validation statistics

3.2.1 The results for Euston from the TfL Technical Note, in particular the numbers of passengers inbound and outbound on NR services in each time period, (available in Tables 7 and 19 of TfL's Technical Note), are reproduced in Table 1. More detailed localised investigations are covered later in this report.

Table 1: Railplan validation results for Euston (TfL): NR passenger flows (2007)

Time period	Inbound			Outbound		
	Observed	Modelled	% Diff	Observed	Modelled	% Diff
AM peak period	17,121	17,214	1%	4,041	4,213	4%
PM peak period	5,065	5,742	13%	15,766	14,476	-8%

3.2.2 It can be seen that at this localised level, both the AM and PM peak period models meet the DfT model validation guidance, as they validate within 15% of observed values (assuming screenline guidance). The AM peak period inbound, which is the dominant peak movement, is particularly strong, within 1% of observed flows.

4 2007 AM peak model

4.1 Base model review

4.1.1 A review has been undertaken on the 2007 Railplan AM peak period model received from TfL. The checks involved interrogating model scenario run details, the model network, passenger demand and model assignment results.

4.1.2 The following sections outline the review undertaken on Euston station interchange and the coding of public transport networks in Railplan. In addition to these model coding checks, the model validation around Euston was reviewed to check the strategic public transport assessment at a local level.

4.1.3 No specific validation exercise has been undertaken on Old Oak Common station rail services as this facility does not exist in the 2007 model. A review of the station coding and service provision has been undertaken on the forecast year models, which does cover base model bus services (as these are used in the forecast years, see section 6.9).

Euston station coding

4.1.4 A number of checks were undertaken on the Euston station coding within the Railplan model. The schematic representation of interchange adopted in Railplan was checked for accuracy at Euston station.

4.1.5 The representation of walk links in the station was also reviewed. In particular, the total passenger flows between the platforms and the station entrance were compared

to the total passenger flows from the station entrance to the bus/walk network. This comparison is set out in Table 2.

Public transport network coding

4.1.6 Detailed investigation was undertaken for the coding of local Bus routes, NR and Underground at Euston station.

4.1.7 Some minor anomalies were found on local bus routes around, and terminating at, Euston. However, these are unlikely to have more than localised impacts, as bus passengers are permitted to walk along the bus route in the model, hence only local stop usage would be affected. These changes were reported to TfL and incorporated into the baseline and with HS2 forecasts.

4.1.8 No significant anomalies in NR or Underground networks were found in the network checking.

4.2 Local validation

4.2.1 The local validation analysis was undertaken on three levels:

- station interchange validation;
- network (link) validation; and
- bus validation.

Interchange validation

4.2.2 A summary of the station interchange validation is presented in Table 2, using data from the 2007 surveys undertaken for TfL (Euston Programme Interchange Study), as these provide a comprehensive and contemporaneous source of observed data.

Table 2: Station interchange validation, 07:00-10:00 (2007): passenger flows

	Mode	Observed	Railplan	Difference	% difference
From	External	3,965	2,858	-1,107	-28%
	Underground	20,965	21,371	406	2%
	NR (Suburban)	14,453	11,975	-2,478	-17%
	NR (Inter-City)	5,729	5,255	-474	-8%
	Total	**45,112**	**41,459**	**-3,653**	**-8%**
To	External	16,502	12,260	-4,242	-26%
	Underground	21,727	24,051	2,324	11%
	NR (suburban)	2,423	2,666	243	10%
	NR (inter-city)	4,460	2,482	-1,978	-44%
	Total	**45,112**	**41,459**	**-3,653**	**-8%**

4.2.3 The Railplan model underestimates the number of NR passengers arriving at Euston station in 2007 during the AM peak period by -15% (-17% on Suburban services and -8% on inter-city services).

4.2.4 Railplan flows from the Underground in total validate well, being within 2% of the observed values, whilst the total flows to LUL are slightly high at +11%.

4.2.5 Because of the impact of ticket pricing, particularly for NR passengers, Railplan has a tendency to over-estimate the interchange between NR and LUL services at NR termini stations such as Euston and under-estimate the transfer to street-based sub modes (walk, cycle, car/taxi and bus); this is apparent in the results.

4.2.6 Flows in the contra-peak direction tend to show a greater difference between Railplan and observed values than those in the peak direction.

4.2.7 In conclusion, the difference between observed and modelled AM peak period flows (including external movements) of -8% indicated a good level of validation, comfortably within the DfT's guidance of +/-15% for screenline flows.

Link validation (NR and LUL)

4.2.8 In order to demonstrate the suitability of Railplan for the assessment of passenger volumes and crowding, a link-based validation was also undertaken around Euston. This is presented in Table 3.

Table 3: Link validation, 07:00-10:00 (2007): passenger flows

	Direction	Modelled	Observed	% difference
NR				
Southbound sub-total		17,213	17,121	1%
Northbound sub-total		4,211	4,041	4%
Underground				
Victoria, north of Euston	NB	18,555	13,433	38%
	SB	53,961	48,721	11%
Victoria, south of Euston	NB	25,202	19,451	30%
	SB	59,082	52,205	13%
Northern Line (Bank branch), north of Euston	NB	12,185	10,924	12%
	SB	22,024	23,772	-7%
Northern Line (Bank branch), south of Euston	NB	11,363	8,593	32%
	SB	25,013	24,571	2%
Northern Line (Charing Cross branch), north of Euston	NB	5,328	7,455	-29%
	SB	23,361	21,943	6%
Northern Line (Charing Cross branch), south of Euston	NB	6,213	8,928	-30%
	SB	24,640	21,906	12%
North of Euston northbound sub-total (LUL)	NB	36,068	31,812	13%
North of Euston southbound sub-total (LUL)	SB	99,346	94,436	5%

	Direction	Modelled	Observed	% difference
South of Euston northbound sub-total (LUL)	NB	42,278	36,972	14%
South of Euston southbound sub-total (LUL)	SB	108,735	98,682	10%
Total		**286,926**	**261,902**	**10%**

Source of observed flows: Rail from Railplan Validation Report; LUL derived from TfL RODS data

4.2.9 Total modelled northbound and southbound flows on NR are within 1% southbound (peak direction) and 4% northbound, well within the DfT validation guidance of 15% of the observed.

4.2.10 North of Euston, total modelled northbound and southbound flows on the Underground are within 13% and 5% respectively of the observed, within the DfT validation guidance.

4.2.11 South of Euston, total modelled northbound and southbound flows on the Underground are within 14% and 10% respectively of the observed, again within the DfT validation guidance.

4.2.12 Individual modelled link flows meet the DfT validation requirements (25%), with the following exceptions:

- northbound Victoria Line north and south of Euston, although this is the counter peak direction;
- northbound Northern Line (Bank branch) south of Euston, although this is the counter peak direction; and
- northbound Northern Line (Charing Cross branch) north and south of Euston although this is the counter peak direction.

4.2.13 In conclusion, whilst these five links all show differences greater than 25%, they are all in the contra-peak direction.

Bus validation

4.2.14 Table 4 shows how Railplan bus boarding and alighting passengers within a 'cordon' around Euston station compares with observed data.

Table 4: Bus 'cordon' validation, 07:00–10:00 (2007): passenger flows

Railplan			BODS			% difference		
Board	Alight	Total	Board	Alight	Total	Board	Alight	Total
2,333	2,004	4,337	4,328	3,845	8,172	-46%	-48%	-47%

BODS = TfL Bus Origin Destination Surveys

4.2.15 It should be noted that the 'Regional Railplan Validation' Technical Note states that bus boarding and alighting validation is good at an aggregate sub-regional level but that flow validation is weak on an individual link basis.

4.2.16 Railplan bus usage within the Euston cordon is 47% lower than observed, which falls short of DfT validation guidance.

4.2.17 However, it should be borne in mind that BODS is, in itself, an estimate of passenger movements derived from a complex data collection exercise, rather than a direct observation or count).

4.2.18 Moreover, the poor level of bus flow validation is considered, in part, to reflect the limited representation of 'short hop' bus journeys in the demand data derived from LTS and is a reflection of the wider weak link flow validation. In addition, Railplan does not take account of fares and ticketing issues in the route and sub mode choice; as a result, the split between bus and walk for local journeys is poorly handled.

4.3 Conclusions – 2007 AM peak model

4.3.1 It is concluded that the 2007 AM peak period model is a reasonable basis for the HS2 TA, as the overall passenger flow in and out of Euston station, the overall interchange flow at Euston station and the overall link validation for NR all meet DfT public transport model validation guidance. This is considered reasonable given the scale and complexity of the model and the paucity of good observed data for either model development or validation.

4.3.2 The overall bus passenger flow around Euston falls short of DfT validation guidance. As this is likely to be due to the limited representation of shorter bus journeys from the Euston area, it may not affect the passenger volumes through Euston station. However, absolute bus flows should be used with caution in the TA.

4.3.3 A number of links are identified that do not meet the DfT model validation guidance. As these are for individual flows within a strategic model, and many are in the contra-peak and less critical direction, they are not considered to be a significant issue. However, these link flows should be used with caution in the TA.

4.3.4 As with all such models, the change in flows between tests should offer greater confidence than the absolute values in any particular test.

5 2007 PM peak model

5.1 Base model review

5.1.1 A review has been undertaken on the 2007 Railplan PM peak period model received from TfL. The same checks were undertaken as for the AM peak period model, as presented in the following sections.

5.2 Local validation

5.2.1 The local validation analysis was undertaken on three levels:

- station interchange validation;
- network (link) validation; and
- bus validation.

Interchange validation

5.2.2 A summary of the station interchange validation is presented in Table 5, using data from the 2007 surveys undertaken for TfL (Euston Programme Interchange Study), as for the AM peak period.

Table 5: Station interchange validation, 16:00-19:00 (2007): passenger flows

	Mode	Observed	Railplan	Difference	% difference
From	External	16,158	11,093	-5,065	-31%
	Underground	26,427	23,773	-2,654	-10%
	NR (suburban)	4,204	2,506	-1,698	-40%
	NR (inter-city)	5,992	3,459	-2,533	-42%
	Total	52,781	40,830	-11,951	-23%
To	External	6,530	3,969	-2,561	-39%
	Underground	22,892	22,160	-732	-3%
	NR (suburban)	13,513	10,854	-2,659	-20%
	NR (inter-city)	9,846	3,847	-5,999	-61%
	Total	**52,781**	**40,830**	**-11,951**	**-23%**

Source of observed flows: Euston programme interchange study (TfL; 2008)

5.2.3 The Railplan PM peak period model does not validate to within 15% against observed passenger flows within the station complex. Modelled flows are 23% lower than observed in both directions.

5.2.4 The Railplan model underestimates the number of NR passengers arriving at Euston station in 2007 during the PM peak period by -42% (-40% on Suburban services and -40% on Inter-City services).

5.2.5 Railplan flows from the Underground in total validate well, being within 10% of the observed values, which is within the DfT guidance.

Link validation (NR and LUL)

5.2.6 A link-based validation was undertaken around Euston for the PM peak period, as shown in Table 6.

Table 6: Link validation, 16:00-19:00 (2007): passenger flows

	Direction	Modelled	Observed	% difference
NR				
Southbound sub-total		5,743	5,065	13%
Northbound sub-total		14,479	15,766	-8%
Underground				
Victoria, north of Euston	NB	51,067	42,123	21%
	SB	27,957	19,961	40%
Victoria, south of Euston	NB	57,190	48,414	18%

	Direction	Modelled	Observed	% difference
	SB	33,425	24,653	36%
Northern Line (Bank branch), north of Euston	NB	23,132	20,424	13%
	SB	13,215	12,357	7%
Northern Line (Bank branch), south of Euston	NB	22,154	19,245	15%
	SB	12,698	12,675	0%
Northern Line (Charing Cross branch), north of Euston	NB	16,887	17,619	-4%
	SB	15,519	13,739	13%
Northern Line (Charing Cross branch), south of Euston	NB	18,783	20,681	-9%
	SB	15,997	14,415	11%
North of Euston northbound sub-total (LUL)	NB	91,086	80,166	14%
North of Euston southbound sub-total (LUL)	SB	56,691	46,057	23%
South of Euston northbound sub-total (LUL)	NB	98,127	88,340	11%
South of Euston southbound sub-total (LUL)	SB	62,120	51,743	20%
Total		**328,246**	**287,137**	**14%**

Source of observed flows: Rail from Railplan Validation Report, LUL derived from TfL RODS data

5.2.7 Total modelled northbound and southbound flows on NR are 8% and 13% of the observed, which meets the DfT validation guidance of 15%.

5.2.8 North of Euston, total modelled northbound and southbound flows on the Underground are within 14% and 23% respectively of the observed. The peak direction is therefore within the DfT guidance for screenline flows of 15%, whilst the contra peak flow is outside.

5.2.9 South of Euston, total modelled northbound and southbound flows on the Underground are within 11% and 20% respectively of the observed. The peak direction is therefore within the DfT guidance for screenline flows of 15%, whilst the contra peak flow is outside.

5.2.10 Individual Modelled link flows generally meet the DfT validation guidance (25%), with the only exception being the Victoria Line southbound north and south of Euston, which is in the contra-peak direction.

5.2.11 In conclusion, whilst these two links all show relatively large (i.e. greater than 25%) differences, they are all in the contra-peak direction.

Bus validation

5.2.12 Table 7 shows the comparison of Railplan bus boarding and alighting passengers within a 'cordon' around Euston station with observed data.

5.2.13 It should be noted that the 'Regional Railplan Validation' Technical Note states that bus boarding and alighting validation is good at an aggregate sub-regional level but that flow validation is weak on an individual link basis.

Table 7: Bus 'cordon' validation, 16:00–19:00 (2007): passenger flows

Railplan			BODS			% difference		
Board	Alight	Total	Board	Alight	Total	Board	Alight	Total
1,654	2,420	4,074	5,236	5,167	10,404	-68%	-53%	-61%

BODS = TfL Bus Origin Destination Surveys

5.2.14 Railplan bus usage within the Euston cordon is 61% lower than observed, which falls short of DfT validation guidance.

5.2.15 The same comments apply as for the AM peak period model, i.e. that this reflects the limited representation of 'short hop' bus journeys and does not take account of fares and ticketing issues in the route and sub mode choice.

5.2.16 It should also be noted that the PM peak period model is less well developed by TfL than the AM peak period model and a poorer level of local validation may reflect this lower level of model development.

5.3 Conclusions – 2007 PM peak model

5.3.1 The 2007 PM peak period model validates slightly less well than the AM peak period model, with the NR screenline and peak direction LUL screenline meeting the DfT public transport model validation guidance. The contra peak LUL screenline falls outside the 15% DfT guidance. However, on an individual link basis, all LUL lines fall within the DfT guidance of 25% with the exception of the Victoria Line southbound, which is again for the contra peak direction.

5.3.2 The slightly poorer validation is probably a reflection of the fact that the PM peak period model is less well developed than the AM peak period model.

5.3.3 The poorer validation in the PM peak period model should therefore be recognised when interpreting results for the TA.

5.3.4 As with all such models, the change in flows between tests should offer greater confidence than the absolute values in any particular test.

6 Future year models

6.1.1 Preliminary model checks were carried out on the future year Railplan models that were developed by TfL. The checks were conducted on the future baseline and future baseline plus operation model assignment runs in order to determine if the models

were suitable for the Euston and Old Oak Common stations TA. Any required amendments to the coding were identified and provided to TfL who incorporated them into Railplan.

6.1.2 The model checks entailed interrogation of the modelling scenarios, network, traffic demand and the model assignment, with particular emphasis on the modelling in and around Euston and Old Oak Common.

6.1.3 The following areas of the modelling have been reviewed:

- HS2 services;
- NR services;
- LUL services;
- bus services; and
- station walk links, including connection with LUL Euston Square.

6.2 Demand

6.2.1 To model the impact of HS2 with Railplan, TfL has replaced Railplan long distance rail demand for the AM and PM peak periods with long distance rail data from PLANET provided by HS2. The data was not adjusted other than a redistribution of trip ends within the Greater London Authority (GLA) area.

6.2.2 The remaining elements of the demand, representing travel by public transport within south east England, are derived from the LTS model for TfL 'Reference Cases' for the two forecast years concerned, 2026 and 2041.

6.2.3 Railplan is an assignment model and uses a fixed demand matrix derived from LTS. However, The Planet Framework Model (PFM) version 4, allows for the inclusion of induced demand due to released track capacity. Therefore, an adjustment was applied to 'suburban' demand on the WCML in Railplan to reflect the impact of induced trips.

6.2.4 The long distance demand data is an output from the PFM, which has been run for two years (2026 and 2036) for two supply side systems (future baseline and future baseline plus operation). PFM long distance demand for 2036 is not adjusted to 2041 in Railplan. As regards HS2, the supply assumptions are:

- HS2 Phase One (London to West Midlands) in 2026; or
- HS2 Phase Two ('Y network' serving Manchester and Leeds) in 2036/2041.

6.3 Railplan scenarios

6.3.1 The following scenarios have been reviewed at this stage:

- 2026 baseline;
- 2026 baseline plus operation;
- 2041 baseline; and

- 2041 baseline plus operation.

6.3.2 On the supply side, other than the changes resulting from the introduction of HS2 (including a change in the NR service patterns), the pattern of services and train capacities operated are assumed not to change between 2026 and 2041, despite a change in the level of demand served.

6.4 HS2 services

6.4.1 Railplan models the HS2 Services as two parallel services, one from West Midlands to Old Oak Common, and the other from West Midlands to Euston. The implementation of these parallel services was agreed with HS2 Ltd in order to facilitate multi-routing at Old Oak Common to the same destination. This, in itself, will not significantly impact on the results derived from the model runs.

6.4.2 Within Railplan, HS2 services assume 1,250 seats per train, as opposed to the standard 1,100 seats/train assumed for HS2. The capacity of HS2 services was deliberately set high to avoid any crowding issues between the parallel services. Although this may lead to a slightly lower level of crowding being forecast by Railplan, it is not a cause for concern.

6.4.3 Finally, a service frequency of 16 tph rather than 9 tph was originally coded in the 2026 test. Although this also is unlikely to lead to significant effects, it was amended in the final runs to 9 tph.

6.5 National Rail services at Euston and King's Cross

6.5.1 As noted, there is no difference between the supply assumptions between 2026 and 2041 for the baseline scenarios.

6.5.2 When comparing the operations scenario with the equivalent baseline, there are changes to the NR service pattern on the West Coast Main Line in both years; these are further detailed below and in Table 8. There are also consequential changes to Great Western services associated with the amended Crossrail services. In addition, and only in 2041, there is a small reduction of services on East Coast to King's Cross (1.67 tph reduction) and from King's Cross (3 tph reduction); these were anticipated.

6.5.3 The NR services inbound to Euston are summarised in Table 8 for the AM peak period. It can be seen that a shift has been assumed from Long Distance (e.g. Virgin West Coast) to Suburban (e.g. London Midland Trains) services, within a consistent supply of 24 tph.

Table 8: Future National Rail services inbound to Euston (tph)

	Trains per hour (NR services) inbound at Euston		
Scenario	**Long distance (VWC) services**	**Suburban (LMT/LOL) services**	**Total services**
2026 baseline	10.3	13.7	24.0
2026 baseline plus operations	6.0	18.0	24.0
2041 baseline	10.3	13.7	24.0

	Trains per hour (NR services) inbound at Euston		
2041 baseline plus operations	6.0	18.0	24.0

6.5.4 A minor issue relates to the coding of proposed NR services between Northampton and Euston. These have been coded in Railplan as 'EI' services, implying an InterCity service, but using Suburban nodes at Euston. This is a function of the HS2 specification which indicates that whilst all current Northampton services are 'Suburban', this service is included amongst inter-city services and operated by Pendolino stock. Being more of a presentational issue than an error, it does not justify amendment, although it will necessitate some care when results are abstracted and interpreted.

6.6 National Rail services at Old Oak Common

6.6.1 As noted, there is no difference between the supply assumptions between 2026 and 2041 for the baseline scenarios.

6.6.2 The operations scenario introduces significant change to rail services on the Great Western Main Line, where all services are coded to stop at Old Oak Common. Main line services have board and alight restrictions to restrict them being used for the short leg between Old Oak Common and Paddington. Earlier versions of the operations scenario had incorrect coding of national rail services at different platforms at Old Oak Common, which have since been corrected.

6.6.3 The NR services eastbound at Old Oak Common are summarised in Table 9 for the AM peak period. The Relief Line - also referred to as slow line - services are predominantly Crossrail (24 tph) services. The main line service provision includes Heathrow Express.

Table 9: Future National Rail services eastbound at Old Oak Common (tph)

	Trains per hour (national services) eastbound at Old Oak Common		
Scenario	Main line services	Relief line services	Total services
2026 baseline	n/a	n/a	n/a
2026 baseline plus operations	17.3	26.7	44.0
2041 baseline	n/a	n/a	n/a
2041 baseline plus operations	17.3	26.7	44.0

6.7 LUL services

6.7.1 As noted, there is no difference between the supply assumptions between 2026 and 2041. Also there is no difference between the two scenarios (baseline or operations). Hence, there is no change to LUL service specifications at Euston or around Old Oak Common.

6.8 Bus services at Euston

6.8.1 As noted, there is no difference between the supply assumptions between 2026 and 2041. Also there is no difference between the two scenarios (baseline or with operations) in the vicinity of Euston.

6.8.2 Also, there is no difference in the supply assumptions from 2007 to either future year forecast in the vicinity of Euston.

6.8.3 On detailed checking, a routing error on bus route 73 (westbound from Euston towards Victoria) was identified. As coded, the route undertakes two u-turns at adjacent nodes, numbers 219001 and 217007, leading to higher frequency at those nodes, but a slightly longer journey time for all potential passengers in this section.

6.9 Bus services at Old Oak Common

6.9.1 As noted, there is no difference between the supply assumptions between 2026 and 2041.

6.9.2 A high level assumption has been made by TfL to extend several bus services to serve the new Old Oak Common station; routes 7, 72 and 283 are extended from Brunel Road (to the south of the station) and route 487 is extended from Willesden Junction station (to the north of the station).

6.9.3 Review of the above assumptions highlighted two issues which have since been corrected. The first was the omission of route 228, which is the only service to currently run on Old Oak Common lane and serve the existing site; this correction has been implemented in the baseline and operations scenarios, but not the 2007 Base model. The second was the extension of route 72 omitted the stop at Old Oak Common; this correction has been implemented in the operations scenarios.

6.9.4 Overall this provides a total bus service of 34 buses per hour in each direction at Old Oak Common station in the 2026 and 2041 operations scenarios.

6.10 Station walk links at Euston

6.10.1 The operations scenarios take account of the proposed amendments to the Euston station as contained in the March 2013 design. Due to the timing of its release, TfL was not able to implement the amendments issued in the June 2013 design. In particular:

- Hampstead Road entrance remains exclusive to HS2 passengers; and
- a new LUL station entrance into Euston Gardens has been modelled.

6.10.2 TfL's view, in subsequent discussions, was that revising Hampstead Road would further delay the programme and opening it up to NR passenger would have a small effect. Accordingly, it was agreed to retain coding based on the March 2013 design. A sensitivity test was undertaken by Arup to confirm this and concluded that it does not have a significant impact on the station flows.

6.10.3 Checking of walk links showed the HS2 interchange links to be coded in Railplan consistently shorter than shown on the March 2013 design drawings. It transpired that these had been coded on the basis of a 50m walk length along the platform (consistent with that coded for NR termini). However, the station layout has access at the end of the platform, with train lengths of 200m and 400m. Therefore, in the final tests provided by TfL, the coding was amended to an agreed length of 150m.

6.11 Station walk links at Old Oak Common

6.11.1 The specification of walk links within Old Oak Common station and connecting to the external network is identical between 2026 and 2041 operations scenarios.

6.11.2 The interpretation of design drawings and implementation as Railplan coding is open to variance, particularly when considering measurement points and vertical movement. A comparison was made between the latest coded Railplan station link lengths and an equivalent set calculated independently of TfL. These showed an acceptable level of variance and no further changes were advised.

6.11.3 Sensitivity tests have been undertaken to investigate the impact of walk link lengths on the level of interchange and access/egress at Old Oak Common. The model has been found to be sensitive to change, so future iterations of the model should adjust link lengths with caution and, more importantly, implement them in a consistent manner to those currently coded.

6.11.4 The station movement matrix provides important input into the TA and station design of Old Oak Common. Particular issues have been noted that are a result of limitations of a strategic model and require an element of professional judgement. For example, Railplan forecasts a very high number of people interchanging from Main Line (eastbound) to Crossrail (eastbound) services in the AM peak, which is sensible, however, Railplan also forecasts a high level of interchange in reverse at Old Oak Common in the PM peak; this is debatable due to behavioural factors not accounted for in the model.

6.12 Concluding summary

6.12.1 Checks were undertaken on Railplan model data received from TfL. The data related to preliminary versions of the revised model for 2026 and 2041, assuming either the baseline or operations scenarios.

6.12.2 A number of minor coding issues were identified and were communicated to HS2 Ltd and TfL through the fortnightly meeting process. All significant issues have now been addressed and are reflected in subsequent versions of Railplan.

Preliminary analysis of forecast year assignments and sensitivity tests suggests that forecast model output is logical and representative of likely conditions.

Annex C(ii) – CLoHAM Model Performance Report

Contents

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1 Introduction

1.1.1 This Model Performance Report (MPR) covers the development of the Central London Highway Assignment Model (CLoHAM) to provide a revised base year model on which to base the Transport Assessment (TA) for Euston station and its approaches (CFA1). As such, the model will be used for:

- provision of traffic data on which to base the sound and air quality assessment, community assessment and socio-economic assessment for the construction and operational phases of HS2;
- provision of changes in traffic and HGVs for the construction and operational phases of HS2 to undertake the assessment of significance for the Environmental Statement (ES);
- provision of changes in traffic and delay to inform the TA; and
- provision of changes in traffic flows between the base year and forecast scenarios for application to local models.

1.1.2 This report covers the performance of the updated CLoHAM model against observed traffic flow and journey time data, model convergence and a commentary on how the model has performed in forecast mode.

2 Background

2.1.1 Following discussions in early summer 2012 between HS2 Ltd and Transport for London (TfL), it was agreed that the Central London and West London Highway Assignment Models (CLoHAM and WeLHAM respectively) would provide the most appropriate basis for assessing the highway effects of the construction and operational phases of HS2 in London, with CLoHAM being primarily used to assess the construction and operational effects around Euston station and WeLHAM for the remainder of the HS2 route in London.

2.1.2 The Highway Assignment Models (HAM) used for assessing the highway effects of the construction and operational phases of HS2 in London were developed by TfL and were originally calibrated and validated to 2008 for CLoHAM and 2009 for WeLHAM. Further to the initial validation, CLoHAM was refined during 2009 in terms of zoning and network and recalibrated, but maintaining the original 2008 demand data; this is referred to as CLoHAM Production Version 1 (and is referred to in this report as 2009 CLoHAM). This version of CLoHAM included the Congestion Charging Western Extension Zone (CCWEZ). Following public consultation, the CCWEZ was removed in January 2011; accordingly, TfL have provided a further base year version of CLoHAM with CCWEZ removed.

2.1.3 In order to provide as robust as possible a basis for undertaking the TA for HS2 around Euston station, TfL and HS2 Ltd agreed that it would be appropriate to recalibrate CLoHAM using up-to-date observed count and journey time data collected in 2012.

2.1.4 As part of their planned updates, TfL collected extensive survey data across all HAM areas during Spring and Autumn 2012. These can be summarised as:

- 325 two-week Automatic Traffic Counts (ATCs) supported by one-day Manual Classified Counts (MCCs);
- 178 MCCs only, 88 of which were four-day MCCs; and
- 308 two-week ATCs only.

2.1.5 In addition, a significant data collection exercise was undertaken in the environs of Euston Station by Arup in summer 2012, comprising ATCs, MCCs, journey time surveys, origin-destination surveys and queue length surveys.

2.1.6 The scope and methodology for the recalibration of CLoHAM was discussed and agreed with TfL.

2.1.7 With respect to the level of model performance and guidance recommended, it should be noted that HS2 will deliver large volumes of rail passenger into Euston station in the morning peak, the majority of whom will use LUL, bus, rail, walk or cycle as onward modes in order to reach their ultimate destination. The public transport effects will be wholly assessed using a TfL-refined version of the Railplan model. The highway effects for each phase are likely to be more modest and can be summarised as:

- construction phase – effect of any temporary road closures, changes to taxi pick up/set down arrangements, removal of car parking plus construction traffic; and
- operational phase - effect of any permanent changes to the higher network as part of the scheme, together with changes in volume and arrangements for taxi pick up/set down movements, offset by removal of car parking at the station.

3 Calibration and validation data

3.1 Introduction

3.1.1 The data available for the recalibration and revalidation of CLoHAM can be summarised as:

- 2009 data used for calibration and validation of the original 2009 CLoHAM model;
- June & July 2012 data collected by Arup in the environs of Euston station;
- Spring and Autumn 2012 data collected by TfL; and
- Trafficmaster data provided by TfL for a November 2011 peak hour.

3.2 TfL data for 2009 & 2012

3.2.1 The Spring and Autumn 2012 TfL count data in the CLoHAM area is illustrated in Figure 1.

3.2.2 The counts can be arranged into a number of screenlines and cordons, some of which were partially counted in both 2009 and 2012, namely, the Central, Inner, Northern and Thames Screenlines.

3.2.3 Figure 2 overlays the 2009 CLoHAM screenline data on the 2012 data. This indicates that there were a number of 2009 screenlines reported in the CLoHAM dashboard that were not re-surveyed in 2012 (and shown as red dots). Conversely, there are a number of locations surveyed in 2012 but not in 2009 (light blue dots). Those sites surveyed in both 2009 and 2012 are represented by darker blue dots.

3.2.4 The CLoHAM calibration data can be summarised as enclosure screenlines, existing screenlines, additional screenlines and turning counts. The screenlines are illustrated in Figure 3.

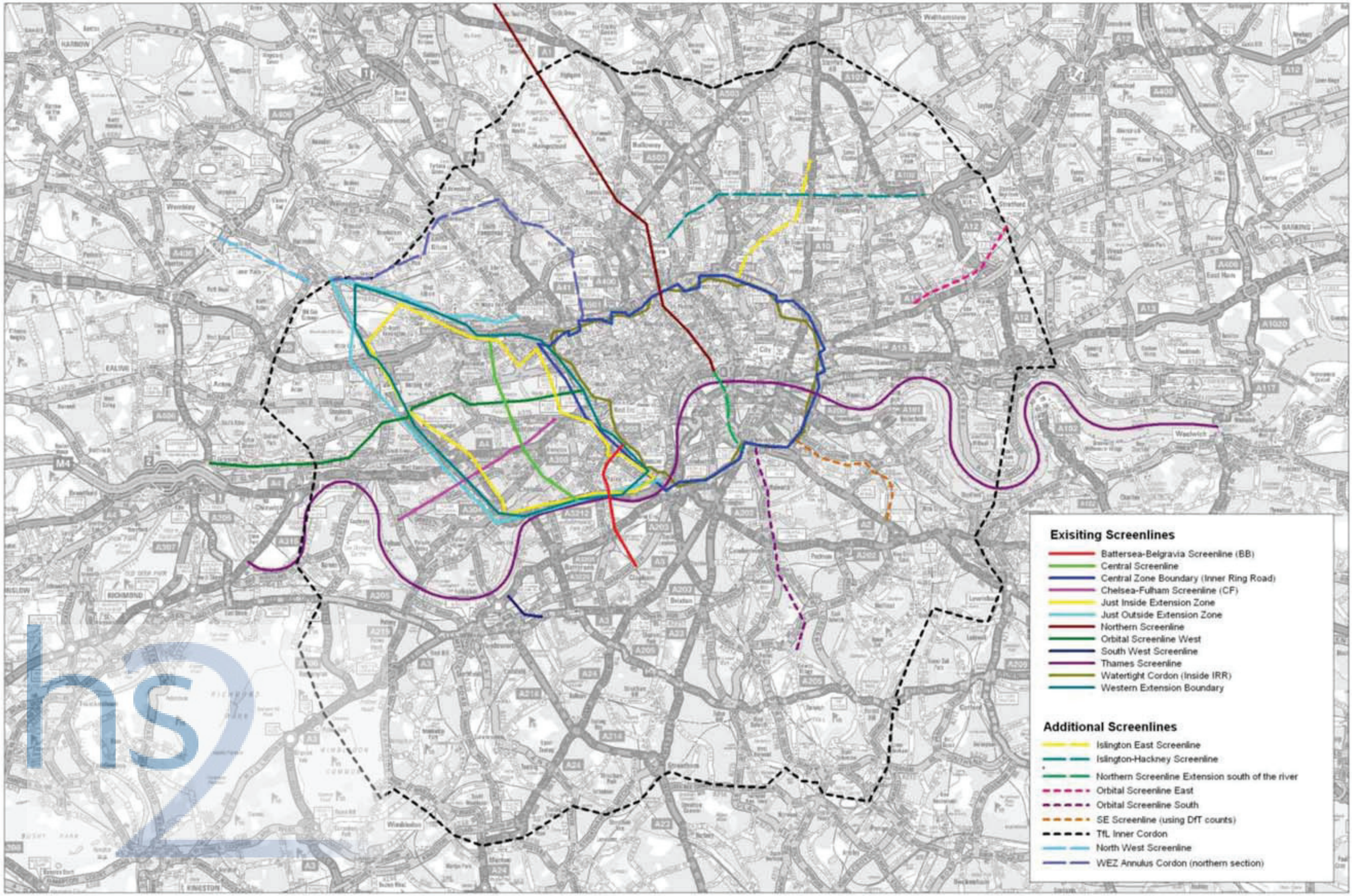
3.2.5 As part of the CLoHAM model development, two screenlines were held back for validation, namely:

- the Just Outside the Extension Zone (JOEZ) screenline; and
- the River Thames screenline.

Figure 1: TfL Spring and Autumn 2012 counts in CLoHAM area

Figure 2: TfL 2012 and 2009 counts

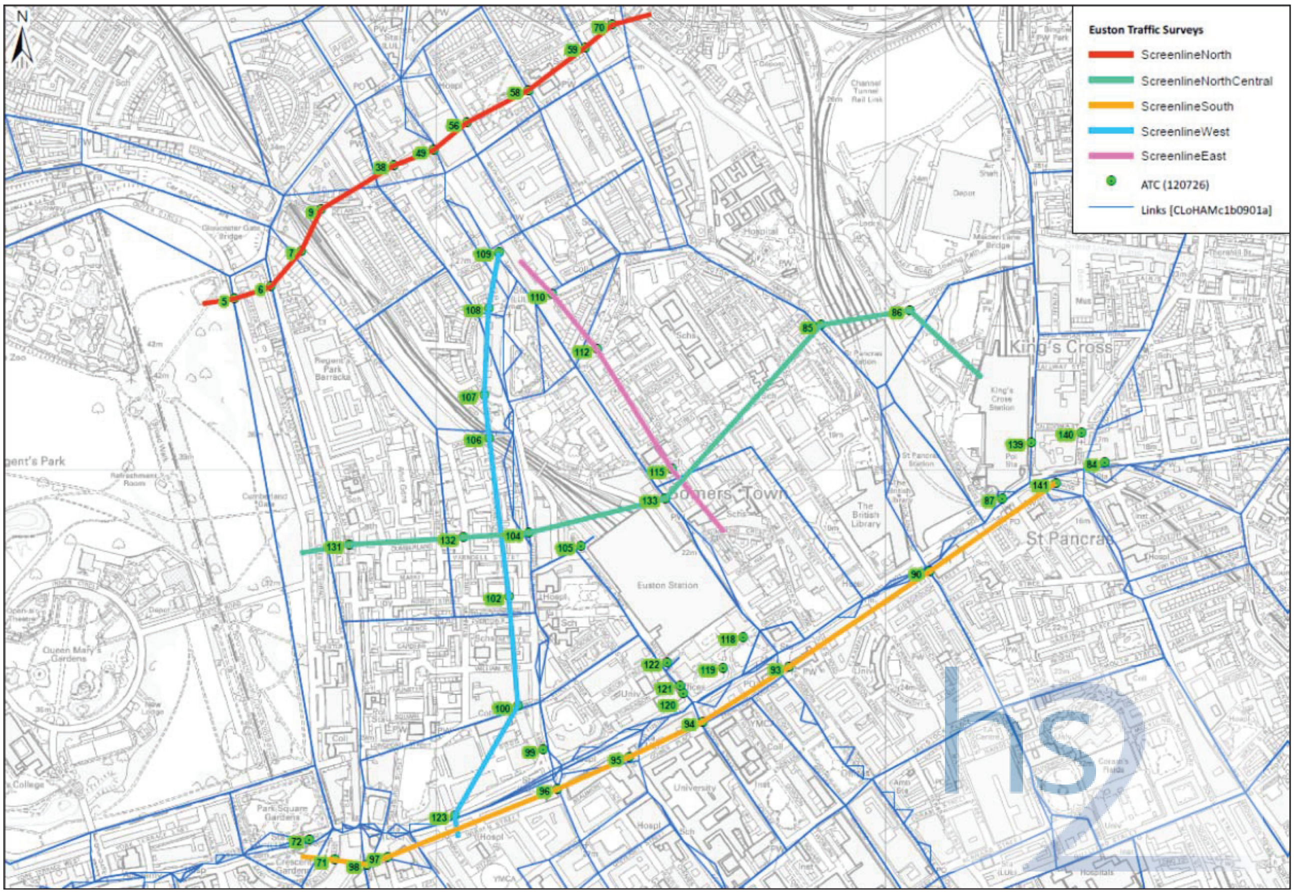
Figure 3: CLoHAM 2009 screenlines (from CLoHAM Model Development & Validation Report)



3.3 Arup June/July 2012 Euston data

3.3.1 A data collection exercise was undertaken in June/July 2012 by Arup in the vicinity of Euston station and is set out in Figure 4. Count data comprised MCCs at junctions and on links, generally supported by ATCs. There are some known issues with some of the busier sites where the ATCs appear to under represent the MCC counts. Journey time surveys using the moving car observer (MCO) method were undertaken in each direction on four routes around Euston.

Figure 4: June/July 2012 Euston data

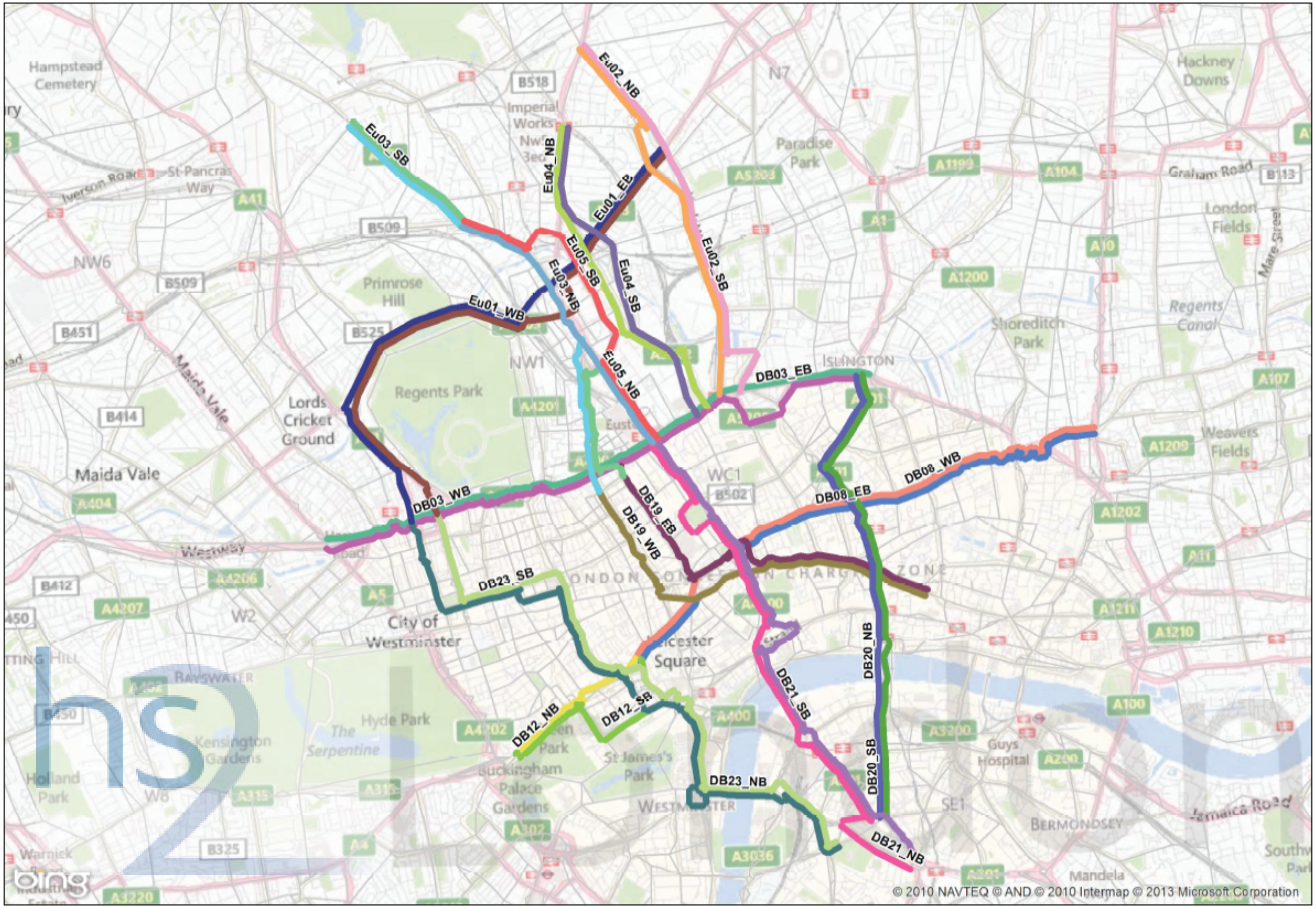


3.4 Trafficmaster data

3.4.1 Trafficmaster data was provided by TfL in order to assess modelled journey time performance. The Trafficmaster dataset recommend by TfL was for November 2011, rather than 2012 data which could have been affected by the closure of the Hammersmith Flyover. TfL recommended using hourly data as it better represents the peak hour conditions (shoulder hours generally having faster journey times/speeds) than an average of the Trafficmaster three-hour peak period. However, it should be noted that previous HAM work was based on three-hour period journey time and that CLoHAM was originally validated against moving car observer (MCO) data.

3.4.2 The routes set out in Figure 5 were specified focusing on the Euston area and Trafficmaster data used to provide observed November 2011 journey times.

Figure 5: CLoHAM journey time routes - 2012 recalibration



4 Calibration process

4.1 Introduction

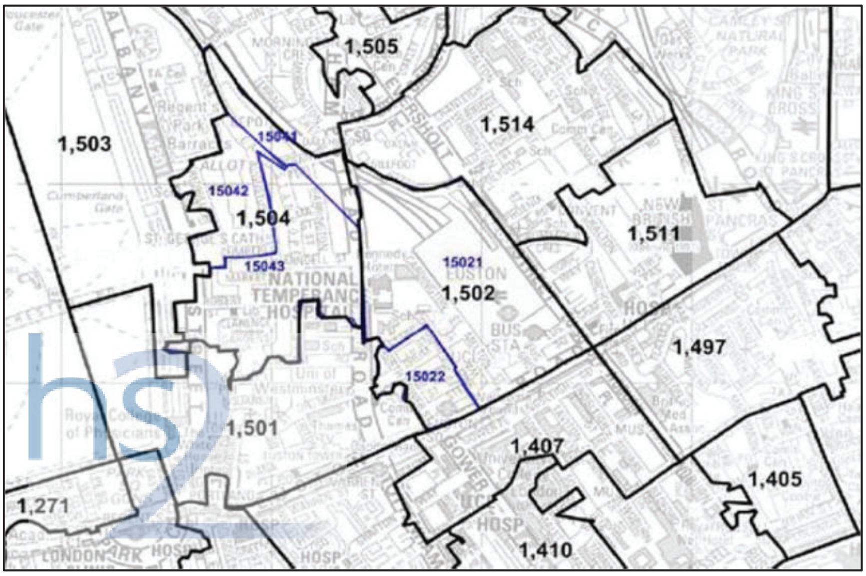
4.1.1 Recalibration of the CLoHAM model included two elements, modification of any known network inconsistencies and errors in the model, together with disaggregation of zones around Euston station and recalibration of the demand matrix based on 2012 observed count data. These are explained in turn below.

4.2 Local model network improvements

4.2.1 The zoning system around Euston is relatively fine. However, as part of the Euston Area Plan (EAP) work, TfL undertook a limited disaggregation of zones around Euston station. This introduced four additional zones as shown in Figure 6. TfL undertook further disaggregation of some of these zones to differentiate between taxi and car drop-off, car pick-up and LGV/HGV access but this post-dated the CLoHAM recalibration.

4.2.2 In order to reflect the different car and taxi access points in zone 15021 (Euston station), zone centroid connectors were introduced which banned certain vehicle types. For example, the centroid connector from Melton Street to the taxi pick-up facility and car park was banned to all other vehicles. Likewise, servicing access was banned to all vehicles apart from LGV and HGV. For the future year scenarios, the centroid connectors were modified to reflect the design of the Proposed Scheme.

Figure 6: EAP zonal disaggregation



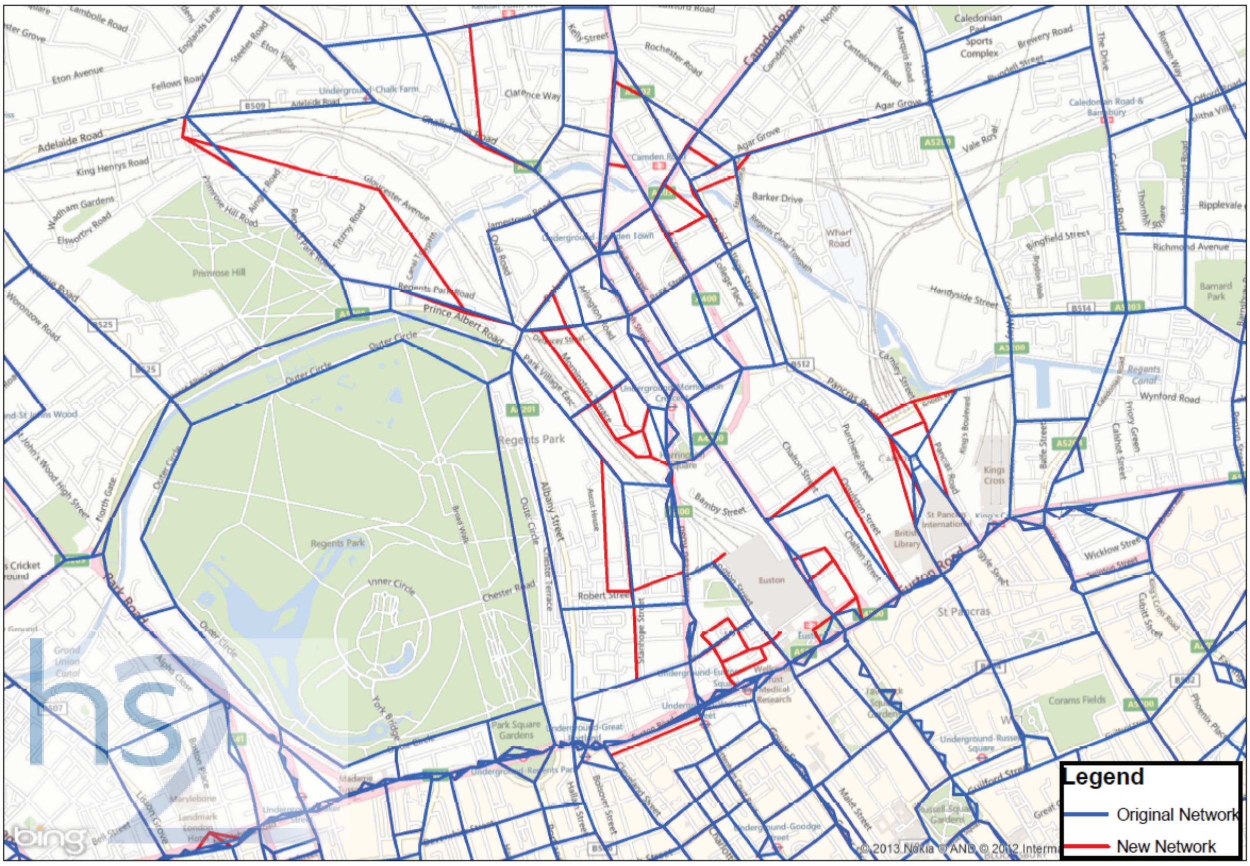
4.2.3 The network was initially amended to remove as many non-fatal errors and serious warnings as possible. This process removed the following non-fatal errors:

- AM: 113 non-fatal errors to one (a u-turn error that could not be resolved);
- IP: 107 non-fatal errors to one (a u-turn error that could not be resolved); and
- PM: 123 non-fatal errors to one (a u-turn error that could not be resolved).

4.2.4 Additional network detail in terms of nodes and links was added in to reflect details of the network now present in the original CLoHAM model. This is shown diagrammatically in Figure 7Figure 7: Modifications to CLoHAM in Euston area which shows the original network in the Euston area in blue together with additional roads in red. This resulted in the following additional roads being added:

- Warren Street;
- Stanhope Street (south of Robert Street);
- Varndell Street;
- Augustus Street;
- Starcross Street;
- Euston Street;
- Cobourg Street;
- North Gower Street;
- Stephensons Way;
- Doric Way;
- Churchway;
- Grafton Place;
- Pancras Road;
- Mornington Terrace (one way northbound);
- Arlington Road;
- Mornington Place;
- King Henrys Road (and Gloucester Avenue);
- Harmood Street;
- Farrier Street;
- Camden Gardens;
- Rousden Street;
- Bruges Place;
- Lyme Street; and
- Georgina Street.

Figure 7: Modifications to CLoHAM in Euston area



4.3 Matrix calibration

4.3.1 The starting point for the 2012 CLoHAM recalibration was the prior matrix from CLoHAM Production Version 1 (in order to avoid matrix estimation on top of a previously matrix estimate model) but with the CCWEZ removed.

4.3.2 Using the data outlined above, a number of options were explored using the 2009 and 2012 data in combination and on their own. Combined 2009 and 2012 counts exceeded 2,000 observations.

4.3.3 However, using the data in combination proved problematic as a number of the 2009 screenlines were either replicated or were close to 2012 screenlines. In addition, the 2012 screenlines were more focussed on central London and arguably formed a better basis for calibration. Following discussions with TfL and HS2 Ltd, early in the calibration process, it was agreed that the most sensible general approach would be to use the 2012 dataset but infill any gaps in the screenlines with 2009 data.

4.3.4 It should be noted that this process, which effectively uses a different set of screenlines to the original 2009 CLoHAM calibration, will produce a different model to the original, with calibration reporting over a different area and different screenlines. This should be borne in mind when interpreting results.

4.3.5 Based on the traffic count analysis, the following steps were undertaken:

1. Update 2009 counts to 2012 levels using the 'global' 2009 to 2012 factors (derived from a comparison of all sites surveyed during both years) of:

   - AM peak reduction of 2.2%;
   - PM peak reduction of 1.2 %; and
   - inter-peak (IP) increase of 1.1%.

2. Cleaning of raw count data and removal of any outliers from 2012 data.

3. Review of differences between the 2012 ATCs and MCCs, summarised in Table 1. This indicated that MCCs were 5% to 10% higher than ATCs in 22% of cases, 10% to 15% higher in 9% of cases and greater than 15% higher in 13% of cases). The following rules were therefore adopted:

   - when the 2012 ATCs and MCCs were within 5%, the ATCs were used for flow and vehicle classification;
   - when the 2012 MCCs were >5% higher than the ATCs, the MCCs were used for flow and vehicle classification; and
   - when the 2012 ATCs were >5% higher than the MCCs%, the ATCs were used for flow and vehicle classification.

4. When the 2009 and 2012 counts were in exactly the same location, the 2012 count was used, irrespective of whether it was an ATC or MCC (or the rules contained in 3).

Table 1: ATC/MCC – hourly records – absolute difference comparison

ATC/MCC classification	Absolute differences (%)				
	<5%	5-10%	10-15%	>15%	Total
Rule 1 (ATC within 5% of MCC)	3,966	18	0	0	3,984
Rule 2 (MCC > 5% higher than the ATC)	0	1,732	725	977	3,434
Rule 3 (ATC > 5% higher than MCC)	0	147	39	79	265
Total	3,966	1,897	764	1,056	7,683 [1]

[1] 7,863 equates to hourly observations - approximately 320 counts x 24 hours

4.3.6 The variability in observed flows (Table 1 indicates that MCCs are >5% higher than ATCs at the same location on the same day in 44% of cases) should be recognised when considering validation guidance.

5 Classification of calibration data

5.1 Introduction

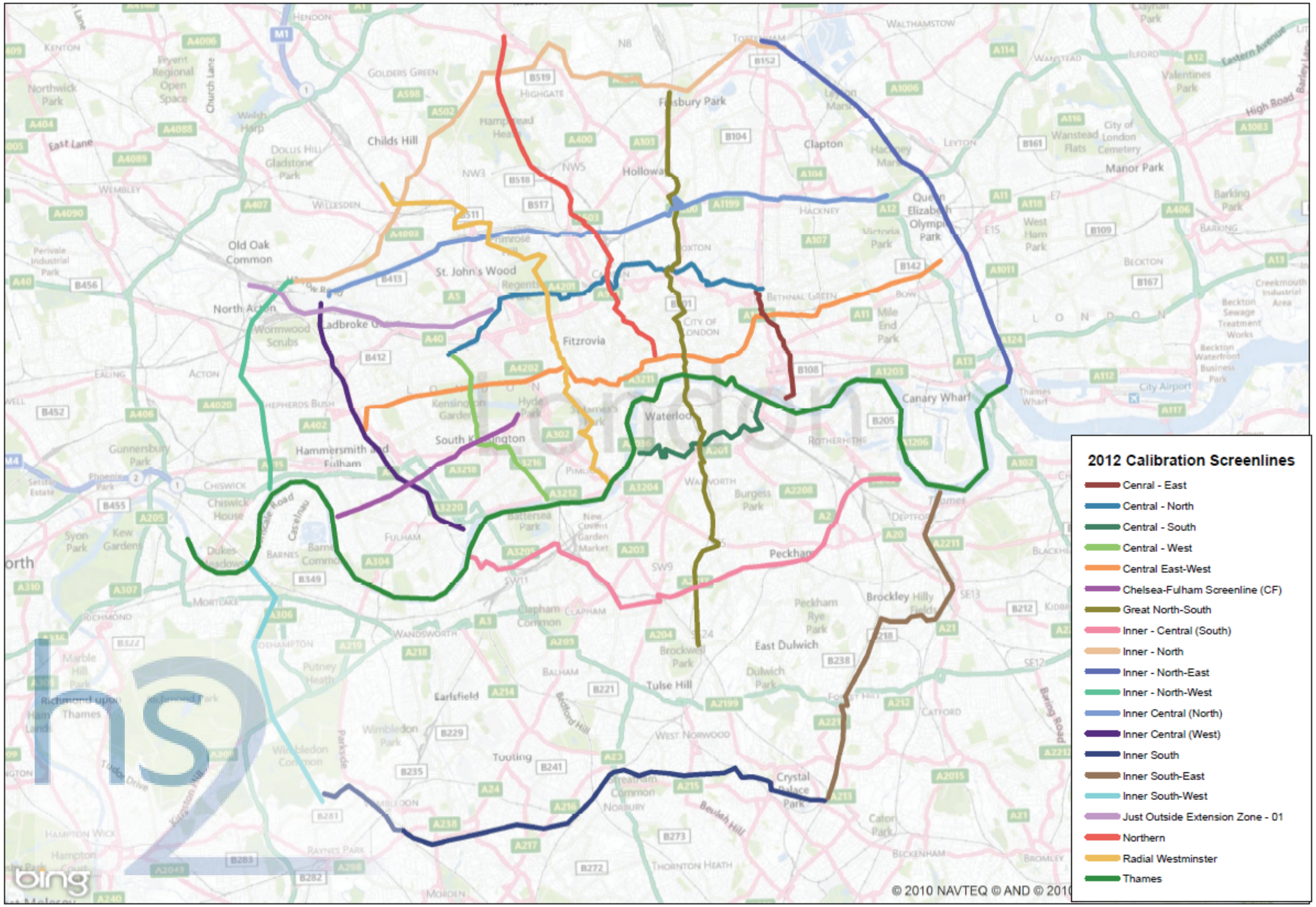
5.1.1 There is a balance between obtaining the best possible model by maximising the number of matrix estimation screenlines and retaining sufficient screenlines to demonstrate that the model validates to an independent set of data. Following advice from TfL, the approach adopted used all count data for calibration in order to produce an optimally validated base year model appropriate for the assessment of the highway effects of HS2.

5.2 Calibration screenlines

5.2.1 Following the analysis of the 2012 dataset, the following screenlines relevant to CLoHAM were extracted and were retained for re-calibration. These are set out in Figure 8.

- Central East-West
- Inner Central (North)
- Central-North
- Inner - Central (South)
- Thames
- Inner-North
- Inner-South
- Central -South
- Inner South-East
- Central-West
- Radial-Westminster
- Inner-SouthWest
- Inner-NorthWest
- Inner-Central (West)
- Central-East
- Northern
- Great North South
- Just Outside Extension Zone - 01
- Chelsea-Fulham Screenline (CF)
- Inner-North-East

Figure 8: 2012 calibration screenlines



6 TfL and DfT guidance

6.1.1 TfL's HAM guidance states:

- **Section 3.2**: "Local Model Validation for both count and flow data should be presented in accordance with current WebTAG Highway Assignment Modelling guidance. TfL will provide the 'dashboard' spreadsheet together with relevant 'key files' and macros to assist in the presentation of model validation."
- **Section 3.5**: "Journey Time validations prepared as part of the HAM LMVR and whose routes pass within the vicinity of the development should be presented and reviewed for acceptability in accordance with current WebTAG Highway Assignment Modelling guidance."
- **Section 3.7**: "Sign off will require the following:
    - Confirmation that matrix estimation has been undertaken from the original prior matrices to an enhanced set of counts for the local area, used where possible as mini-screenlines
    - Model convergence consistent with or better than WebTAG standards (e.g. Minimum duality GAP<0.05 for four successive model iterations)
    - Count validation to original HAM screenlines no worse than provided by the original supplied HAM
    - Journey Time validation to original HAM routes no worse than provided by the original supplied HAM
    - Local area screenline count calibration in line with WebTAG guidance
    - Local area individual count calibration in line with WebTAG guidance, relaxed to the equivalent of a GEH of 7.5 for turning count data presented separately
    - Local area Journey Time validation accurate to within 15 per cent of observed."

6.1.2 TfL's aspirations broadly match the guidelines contained within the DfT's Design Manual for Roads and Bridges (DMRB) Volume 12, which are useful in that they provide different criteria based on different categories of road and are also the DfT's generally acceptable criteria. The DMRB guidelines for flow percentage differences, Geoffrey E. Havers (GEH) flow statistics and journey times are reproduced in Table 2.

Table 2: DMRB model performance guidelines

Criteria	Acceptability guideline
Assigned hourly flows	
Individual flows within +/-15% for flows 700-2,700 vph	>85% of cases
Individual flows within +/-100 vph for flows <700 vph	>85% of cases
Individual flows within +/-400 vph for flows >2,700 vph	>85% of cases

Criteria	Acceptability guideline
Screenline flows (normally >5 links) to be within 5% All	All or nearly all screenlines
GEH statistic	
Individual flows GEH <5	>85% of cases
Screenline totals GEH <4	All or nearly all screenlines
Journey times	
Modelled journey times within 15% (or 1 minute if higher)	>85% of cases

6.1.3 It should be noted that the DMRB guidelines were originally designed for the assessment of trunk roads rather than the broader and in urban settings extremely dispersed collector/feeder networks. Therefore, for a city of the complexity of central London it is extremely difficult to satisfy all the guidelines outlined in DMRB. Accordingly, there are precedents where the guidelines have been relaxed for SATURN models within London.

7 Model calibration

7.1 Model wide calibration

7.1.1 In order to assist with and report on calibration and validation, TfL's 'Dashboard' spreadsheet was utilised. This provides a detailed analysis of model calibration and validation. Whilst this is at a model-wide level, it is useful in order to compare the results against previous calibrated versions of the model.

7.1.2 The TfL Dashboard provides details of model performance against a number of measures including screenlines, total counts, journey times, trip distribution, etc. It reports a number of 'Topline Statistics', comparing model performance on links, screenlines and for journey time routes. Table 3, Table 4 and Table 5 compare these statistics derived from the original 2009 CLoHAM model (as reported in the CLoHAM LMVR) with the version of CLoHAM updated for the HS2 TA. It should be noted that the count locations and screenlines in the two models are different.

Table 3: Top line statistics – TfL HAM AM peak Dashboard

Criteria	Achieved in original 2009 CLoHAM calibration	Achieved in updated 2012 HS2 TA CLoHAM	TfL aspiration
Links - GEH <8.0 for 2009 CLoHAM, <7.5 for 2012 HS2 TA CLoHAM	89%	90%	85%
Links - DMRB flow criteria	82%	85%	85%
Screenline - flow <5%	53%	70%	85%
Screenline - GEH <4	65%	65%	85%
Journey times - flow difference <15%	66%	63%	85%

Table 4: Top line statistics – TfL HAM IP Dashboard

Criteria	Achieved in original 2009 CLoHAM calibration	Achieved in updated 2012 HS2 TA CLoHAM	TfL aspiration
Links - GEH <8.0 for 2009 CLoHAM, <7.5 for 2012 HS2 TA CLoHAM	87%	91%	85%
Links - DMRB flow criteria	83%	88%	85%
Screenline - flow <5%	61%	73%	85%
Screenline - GEH <4	64%	65%	85%
Journey times - flow difference <15%	58%	63%	85%

Table 5: Top line statistics – TfL HAM PM Peak Dashboard

Criteria	Achieved in original 2009 CLoHAM calibration	Achieved in updated 2012 HS2 TA CLoHAM	TfL aspiration
Links - GEH <8.0 for 2009 CLoHAM, <7.5 for 2012 HS2 TA CLoHAM	88%	89%	85%
Links - DMRB flow criteria	82%	86%	85%
Screenline - flow <5%	53%	63%	85%
Screenline - GEH <4	50%	60%	85%
Journey times - flow difference <15%	60%	63%	85%

7.1.3 From this it is apparent that whilst the original 2009 CLoHAM model meets TfL's aspirations for links with a GEH statistic less than 8.0, it fell short on the other criteria. However, the 2012 recalibration for the Euston HS2 TA shows model-wide improvements in most of the top line statistics with overall link validation improving to around 90% (despite being measured against a more stringent GEH criteria of less than 7.5). The number of individual links meeting DMRB guidance are within acceptable limits for all time periods. The biggest improvement is in screenline flows with the number of screenlines with a flow difference of <5% improving by between 10% (PM) and 17% (AM).

7.1.4 Journey times are measured differently compared with the 2009 calibration where modelled journey times were compared with MCO data. TfL now utilises Trafficmaster data which has a much greater sample size and is available by month. Previous HAM model calibration has been undertaken against three-hour peak data (which, all other things being equal would tend to give quicker journey times than a peak hour). However, the Trafficmaster data can now be interrogated for peak hour observations and so this data was used in calibration. Due to likely variability associated with 2012 data (Hammersmith Flyover closures, London 2012 Olympic & Paralympic Games), data was provided for November 2011.

7.1.5 The Trafficmaster calibration is generally very similar to that achieved in the 2009 calibration with a small worsening in the AM peak, compared with small improvements in both the IP and PM peaks. The modelled journey times are consistently faster than the Trafficmaster data for all three modelled hours, reflecting the fact that the original 2009 CLoHAM model was calibrated against MCO data rather than Trafficmaster.

7.1.6 The detailed journey time calibration by time period is reproduced in Table 6, Table 7 and Table 8 for the AM, IP and PM respectively.

Table 6: AM peak Journey time validation

Description	Start	Finish	Dist (km)	Obs (sec)	Mod (sec)	% diff	Meets DMRB
Route 3: WB	Angel	LUL Edgware Road	5.03	1,543	1,101	-29%	No
Route 3: EB	LUL Edgware Road	Angel	4.80	1,202	1,155	-4%	Yes
Route 8: WB	Shoreditch	Piccadilly Circus	4.96	2,032	1,386	-32%	No
Route 8: EB	Piccadilly Circus	Shoreditch	4.67	1,301	1,410	8%	Yes
Route 12: NB	Piccadilly/ Down St	Piccadilly Circus	1.16	316	275	-13%	Yes
Route 12: SB	Piccadilly Circus	Piccadilly/ Down St	1.83	377	350	-7%	Yes
Route 19: WB	Newgate St/ King Edward St	LUL Warren Street	3.55	1,052	915	-13%	Yes
Route 19: EB	LUL Warren Street	Newgate St/ King Edward St	3.38	830	806	-3%	Yes
Route 20: NB	St George's Circus (Lambeth)	LUL Angel	3.96	1,165	1,018	-13%	Yes
Route 20: SB	LUL Angel	St George's Circus (Lambeth)	3.97	963	879	-9%	Yes
Route 21: NB	Elephant & Castle	Euston Station	5.05	1,182	981	-17%	No
Route 21: SB	Euston Station	Elephant & Castle	4.64	1,086	1,055	-3%	Yes
Route 23: NB	Imperial War Museum	LUL Baker Street	6.01	1,627	1,559	-4%	Yes
Route 23: SB	LUL Baker Street	Imperial War Museum	5.69	1,648	1,498	-9%	Yes
Route Eu01: EB	A501 Marylebone Rd	York Way/ Camden Rd	4.93	875	811	-7%	Yes
Route Eu01: WB	York Way/ Camden Rd	A501 Marylebone Rd	5.24	1,537	926	-40%	No
Route Eu02: NB	King's Cross Station	LUL Tufnell Park	3.55	655	555	-15%	No
Route Eu02: SB	LUL Tufnell Park	King's Cross Station	3.57	962	699	-27%	No
Route Eu03: NB	Grafton Way	LUL Belsize Park	4.00	732	798	9%	Yes
Route Eu03: SB	LUL Belsize Park	Grafton Way	4.62	969	941	-3%	Yes
Route Eu04: NB	St. Pancras Station	LUL Kentish Town	2.89	678	472	-30%	No
Route Eu04: SB	LUL Kentish Town	St. Pancras Station	2.86	844	510	-40%	No
Route Eu05: NB	Euston Road	LUL Chalk Farm	2.50	491	659	34%	No

Description	Start	Finish	Dist (km)	Obs (sec)	Mod (sec)	% diff	Meets DMRB
Route Eu05: SB	LUL Chalk Farm	Euston Road	2.88	702	643	-8%	Yes

Table 7: IP journey time validation

Description	Start	Finish	Dist (km)	Obs (sec)	Mod (sec)	% diff	Meets DMRB
Route 3: WB	Angel	LUL Edgware Road	5.03	1,602	1,104	-31%	No
Route 3: EB	LUL Edgware Road	Angel	4.80	1,396	1,483	6%	Yes
Route 8: WB	Shoreditch	Piccadilly Circus	4.96	2,214	1,307	-41%	No
Route 8: EB	Piccadilly Circus	Shoreditch	4.67	1,837	1,592	-13%	Yes
Route 12: NB	Piccadilly/ Down St	Piccadilly Circus	1.16	570	580	2%	Yes
Route 12: SB	Piccadilly Circus	Piccadilly/ Down St	1.83	564	422	-25%	No
Route 19: WB	Newgate St/ King Edward St	LUL Warren Street	3.55	1,426	1,121	-21%	No
Route 19: EB	LUL Warren Street	Newgate St/ King Edward St	3.38	1,156	956	-17%	No
Route 20: NB	St George's Circus (Lambeth)	LUL Angel	3.96	1,114	1,009	-9%	Yes
Route 20: SB	LUL Angel	St George's Circus (Lambeth)	3.97	878	825	-6%	Yes
Route 21: NB	Elephant & Castle	Euston Station	5.05	1,264	1,077	-15%	Yes
Route 21: SB	Euston Station	Elephant & Castle	4.64	1,179	1,071	-9%	Yes
Route 23: NB	Imperial War Museum	LUL Baker Street	6.01	1,869	1,530	-18%	No
Route 23: SB	LUL Baker Street	Imperial War Museum	5.69	2,309	1,576	-32%	No
Route Eu01: EB	A501 Marylebone Rd	York Way/ Camden Rd	4.93	918	781	-15%	Yes
Route Eu01: WB	York Way/ Camden Rd	A501 Marylebone Rd	5.24	1,091	987	-10%	Yes
Route Eu02: NB	King's Cross Station	LUL Tufnell Park	3.55	618	560	-9%	Yes
Route Eu02: SB	LUL Tufnell Park	King's Cross Station	3.57	715	744	4%	Yes
Route Eu03: NB	Grafton Way	LUL Belsize Park	4.00	815	763	-6%	Yes
Route Eu03: SB	LUL Belsize Park	Grafton Way	4.62	916	809	-12%	Yes
Route Eu04: NB	St. Pancras Station	LUL Kentish Town	2.89	729	469	-36%	No

Description	Start	Finish	Dist (km)	Obs (sec)	Mod (sec)	% diff	Meets DMRB
Route Eu04: SB	LUL Kentish Town	St. Pancras Station	2.86	734	441	-40%	No
Route Eu05: NB	Euston Road	LUL Chalk Farm	2.50	590	642	9%	Yes
Route Eu05: SB	LUL Chalk Farm	Euston Road	2.88	672	593	-12%	Yes

Table 8: PM peak journey time validation

Description	Start	Finish	Dist (km)	Obs (sec)	Mod (sec)	% diff	Meets DMRB
Route 3: WB	Angel	LUL Edgware Road	5.03	1,869	1,448	-23%	No
Route 3: EB	LUL Edgware Road	Angel	4.80	1,975	1,563	-21%	No
Route 8: WB	Shoreditch	Piccadilly Circus	4.96	1,857	1,427	-23%	No
Route 8: EB	Piccadilly Circus	Shoreditch	4.67	1,822	1,822	0%	Yes
Route 12: NB	Piccadilly/ Down St	Piccadilly Circus	1.16	346	349	1%	Yes
Route 12: SB	Piccadilly Circus	Piccadilly/ Down St	1.83	464	317	-32%	No
Route 19: WB	Newgate St/ King Edward St	LUL Warren Street	3.55	1,215	1,146	-6%	Yes
Route 19: EB	LUL Warren Street	Newgate St/ King Edward St	3.38	954	913	-4%	Yes
Route 20: NB	St George's Circus (Lambeth)	LUL Angel	3.96	1,055	944	-11%	Yes
Route 20: SB	LUL Angel	St George's Circus (Lambeth)	3.97	845	868	3%	Yes
Route 21: NB	Elephant & Castle	Euston Station	5.05	1,401	1,207	-14%	Yes
Route 21: SB	Euston Station	Elephant & Castle	4.64	1,191	1,147	-4%	Yes
Route 23: NB	Imperial War Museum	LUL Baker Street	6.01	1,773	1,523	-14%	Yes
Route 23: SB	LUL Baker Street	Imperial War Museum	5.69	2,048	1,584	-23%	No
Route Eu01: EB	A501 Marylebone Rd	York Way/ Camden Rd	4.93	1,169	791	-32%	No
Route Eu01: WB	York Way/ Camden Rd	A501 Marylebone Rd	5.24	1,061	1,047	-1%	Yes
Route Eu02: NB	King's Cross Station	LUL Tufnell Park	3.55	675	606	-10%	Yes
Route Eu02: SB	LUL Tufnell Park	King's Cross Station	3.57	584	755	29%	No
Route Eu03: NB	Grafton Way	LUL Belsize Park	4.00	850	790	-7%	Yes

Description	Start	Finish	Dist (km)	Obs (sec)	Mod (sec)	% diff	Meets DMRB
Route Eu03: SB	LUL Belsize Park	Grafton Way	4.62	996	850	-15%	Yes
Route Eu04: NB	St. Pancras Station	LUL Kentish Town	2.89	896	618	-31%	No
Route Eu04: SB	LUL Kentish Town	St. Pancras Station	2.86	844	447	-47%	No
Route Eu05: NB	Euston Road	LUL Chalk Farm	2.50	586	656	12%	Yes
Route Eu05: SB	LUL Chalk Farm	Euston Road	2.88	698	620	-11%	Yes

7.1.7 Table 9, Table 10, Table 11 and Table 12 display calibration on screenlines. This indicates overall model calibration of 70%, 73% and 60% for the AM, IP and PM respectively. The AM and IP screenlines perform better than the PM peak. With the exception of the Inner South cordon, which is remote from the Euston area, those screenlines with a percentage difference between observed and modelled flows not meeting the DMRB criteria are generally just above 5% and therefore are close to DMRB.

Table 9: AM peak model-wide screenline validation summary

Screenline	Direction	Observed (PCU)	Modelled (PCU)	% Diff	GEH	Flow Diff <5%	GEH <4
Central East-West	NB	13,611	13,241	-3%	3	Yes	Yes
Central East-West	SB	12,863	12,593	-2%	2	Yes	Yes
Inner Central (North)	NB	9,421	8,983	-5%	5	Yes	No
Inner Central (North)	SB	15,422	14,274	-7%	9	No	No
Central-North	NB	9,206	8,673	-6%	6	No	No
Central-North	SB	14,310	13,050	-9%	11	No	No
Inner-Central (South)	SB	3,347	3,236	-3%	2	Yes	Yes
Inner-Central (South)	NB	4,620	4,295	-7%	5	No	No
Thames	NB	17,431	17,521	1%	1	Yes	Yes
Thames	SB	12,536	12,535	0%	0	Yes	Yes
Inner-North	NB	9,607	9,330	-3%	3	Yes	Yes
Inner-North	SB	13,395	12,519	-7%	8	No	No
Inner-South	NB	13,126	11,323	-14%	16	No	No
Inner-South	SB	8,013	7,075	-12%	11	No	No
Central-South	NB	5,692	5,250	-8%	6	No	No
Central-South	SB	2,967	3,129	5%	3	No	Yes
Inner South-East	WB	6,657	6,649	0%	0	Yes	Yes

Screenline	Direction	Observed (PCU)	Modelled (PCU)	% Diff	GEH	Flow Diff <5%	GEH <4
Inner South-East	EB	4,588	4,599	0%	0	Yes	Yes
Central-West	EB	5,901	6,119	4%	3	Yes	Yes
Central-West	WB	4,364	4,558	4%	3	Yes	Yes
Radial-Westminster	WB	10,539	10,028	-5%	5	Yes	No
Radial-Westminster	EB	11,102	10,450	-6%	6	No	No
Inner-SouthWest	WB	3,866	3,730	-4%	2	Yes	Yes
Inner-SouthWest	EB	4,916	4,836	-2%	1	Yes	Yes
Inner-NorthWest	EB	9,558	9,225	-3%	3	Yes	Yes
Inner-NorthWest	WB	8,706	8,464	-3%	3	Yes	Yes
Inner-Central (West)	EB	10,879	10,663	-2%	2	Yes	Yes
Inner-Central (West)	WB	10,253	10,247	0%	0	Yes	Yes
Central-East	EB	3,020	3,029	0%	0	Yes	Yes
Central-East	WB	4,583	4,732	3%	2	Yes	Yes
Northern	EB	6,581	6,682	2%	1	Yes	Yes
Northern	WB	7,580	6,934	-9%	8	No	No
Great North South	EB	11,850	11,336	-4%	5	Yes	No
Great North South	WB	13,482	12,415	-8%	9	No	No
Just Outside Extension Zone - 01	SB	4,904	4,906	0%	0	Yes	Yes
Just Outside Extension Zone - 01	NB	4,147	3,964	-4%	3	Yes	Yes
Chelsea-Fulham Screenline (CF)	NB	5,906	5,739	-3%	2	Yes	Yes
Chelsea-Fulham Screenline (CF)	SB	5,700	5,729	1%	0	Yes	Yes
Inner - North-East	EB	7,399	7,204	-3%	2	Yes	Yes
Inner - North-East	WB	9,444	9,388	-1%	1	Yes	Yes

Table 10: IP model-wide screenline validation summary

Screenline	Direction	Observed (PCU)	Modelled (PCU)	% Diff	GEH	Flow Diff <5%	GEH <4
Central East-West	NB	13,533	13,327	-2%	2	Yes	Yes
Central East-West	SB	12,910	12,327	-5%	5	Yes	No
Inner Central (North)	NB	10,108	9,617	-5%	5	Yes	No
Inner Central (North)	SB	10,240	9,891	-3%	3	Yes	Yes

Screenline	Direction	Observed (PCU)	Modelled (PCU)	% Diff	GEH	Flow Diff <5%	GEH <4
Central-North	NB	10,705	10,042	-6%	7	No	No
Central-North	SB	9,876	9,665	-2%	2	Yes	Yes
Inner-Central (South)	SB	3,381	3,214	-5%	3	Yes	Yes
Inner-Central (South)	NB	4,024	4,097	2%	1	Yes	Yes
Thames	NB	12,457	12,749	2%	3	Yes	Yes
Thames	SB	12,772	12,800	0%	0	Yes	Yes
Inner-North	NB	10,364	9,559	-8%	8	No	No
Inner-North	SB	10,263	9,202	-10%	11	No	No
Inner-South	NB	8,450	7,742	-8%	8	No	No
Inner-South	SB	8,548	7,802	-9%	8	No	No
Central-South	NB	3,805	3,649	-4%	3	Yes	Yes
Central-South	SB	3,896	3,944	1%	1	Yes	Yes
Inner South-East	WB	4,728	4,686	-1%	1	Yes	Yes
Inner South-East	EB	4,819	4,800	0%	0	Yes	Yes
Central-West	EB	4,834	5,010	4%	3	Yes	Yes
Central-West	WB	4,642	4,786	3%	2	Yes	Yes
Radial-Westminster	WB	10,627	10,218	-4%	4	Yes	No
Radial - Westminster	EB	10,620	9,744	-8%	9	No	No
Inner-SouthWest	WB	3,582	3,382	-6%	3	No	Yes
Inner-SouthWest	EB	3,573	3,319	-7%	4	No	No
Inner-NorthWest	EB	7,935	7,894	-1%	0	Yes	Yes
Inner-NorthWest	WB	8,509	8,318	-2%	2	Yes	Yes
Inner-Central (West)	EB	10,505	10,378	-1%	1	Yes	Yes
Inner-Central (West)	WB	10,889	11,050	1%	2	Yes	Yes
Central-East	EB	3,602	3,110	-14%	8	No	No
Central-East	WB	3,404	3,301	-3%	2	Yes	Yes
Northern	EB	6,106	6,194	1%	1	Yes	Yes
Northern	WB	6,151	6,108	-1%	1	Yes	Yes
Great North South	EB	10,452	9,934	-5%	5	Yes	No
Great North South	WB	9,985	9,138	-8%	9	No	No
Just Outside Extension Zone - 01	SB	4,057	4,086	1%	0	Yes	Yes
Just Outside Extension	NB	4,588	4,414	-4%	3	Yes	Yes

Screenline	Direction	Observed (PCU)	Modelled (PCU)	% Diff	GEH	Flow Diff <5%	GEH <4
Zone - 01							
Chelsea-Fulham Screenline (CF)	NB	6,178	5,979	-3%	3	Yes	Yes
Chelsea-Fulham Screenline (CF)	SB	5,619	5,488	-2%	2	Yes	Yes
Inner-North-East	EB	9,322	7,770	-17%	17	No	No
Inner-North-East	WB	6,454	6,459	0%	0	Yes	Yes

Table 11: PM peak model-wide screenline validation summary

Screenline	Direction	Observed (PCU)	Modelled (PCU)	% Diff	GEH	Flow Diff <5%	GEH <4
Central East-West	NB	14,332	14,134	-1%	2	Yes	Yes
Central East-West	SB	14,011	13,674	-2%	3	Yes	Yes
Inner Central (North)	NB	13,312	12,172	-9%	10	No	No
Inner Central (North)	SB	10,729	10,293	-4%	4	Yes	No
Central-North	NB	13,144	12,226	-7%	8	No	No
Central-North	SB	10,341	10,366	0%	0	Yes	Yes
Inner-Central (South)	SB	4,025	3,538	-12%	8	No	No
Inner-Central (South)	NB	4,140	4,180	1%	1	Yes	Yes
Thames	NB	14,383	14,577	1%	2	Yes	Yes
Thames	SB	17,419	17,495	0%	1	Yes	Yes
Inner-North	NB	14,502	13,020	-10%	13	No	No
Inner-North	SB	10,834	10,348	-4%	5	Yes	No
Inner-South	NB	9,187	8,240	-10%	10	No	No
Inner-South	SB	12,316	10,541	-14%	17	No	No
Central-South	NB	3,825	3,884	2%	1	Yes	Yes
Central-South	SB	5,373	5,353	0%	0	Yes	Yes
Inner South-East	WB	4,777	4,795	0%	0	Yes	Yes
Inner South-East	EB	6,468	6,315	-2%	2	Yes	Yes
Central-West	EB	5,244	5,531	5%	4	No	Yes
Central-West	WB	5,348	5,458	2%	1	Yes	Yes
Radial-Westminster	WB	11,552	10,691	-7%	8	No	No
Radial-Westminster	EB	11,328	9,796	-14%	15	No	No
Inner-SouthWest	WB	5,126	5,060	-1%	1	Yes	Yes

Screenline	Direction	Observed (PCU)	Modelled (PCU)	% Diff	GEH	Flow Diff <5%	GEH <4
Inner-SouthWest	EB	4,169	4,164	0%	0	Yes	Yes
Inner-NorthWest	EB	8,866	8,804	-1%	1	Yes	Yes
Inner-NorthWest	WB	10,056	9,790	-3%	3	Yes	Yes
Inner-Central (West)	EB	11,113	11,149	0%	0	Yes	Yes
Inner-Central (West)	WB	11,903	12,061	1%	1	Yes	Yes
Central-East	EB	4,994	4,713	-6%	4	No	No
Central-East	WB	4,063	4,146	2%	1	Yes	Yes
Northern	EB	7,755	7,171	-8%	7	No	No
Northern	WB	7,023	6,473	-8%	7	No	No
Great North South	EB	13,148	11,956	-9%	11	No	No
Great North South	WB	12,352	11,205	-9%	11	No	No
Just Outside Extension Zone - 01	SB	4,197	4,184	0%	0	Yes	Yes
Just Outside Extension Zone - 01	NB	4,854	4,885	1%	0	Yes	Yes
Chelsea-Fulham Screenline (CF)	NB	6,050	5,944	-2%	1	Yes	Yes
Chelsea-Fulham Screenline (CF)	SB	5,708	5,508	-4%	3	Yes	Yes
Inner-North-East	EB	13,053	10,779	-17%	21	No	No
Inner-North-East	WB	6,375	6,358	0%	0	Yes	Yes

7.2 Local calibration

7.2.1 Local model calibration was performed against observed data and journey times around the Euston area to ensure the model performed consistently at a local level as well as the model-wide level.

Link calibration

7.2.2 Table 12, Table 13 and Table 14 show the full area calibration compared to the local area calibration. The number of links meeting DMRB guidelines in the local area has reduced slightly or maintained the level of performance, which performed very well in the full area model.

7.2.3 There were 24 journey time routes identified for model calibration. However, as these are focussed on the Euston area, they could all be considered as local. Of these routes, 14 were modified from the original 2009 CLoHAM journey time routes with an additional 10 journey time routes specified north of Euston Road (which cover key roads such as Eversholt Street and Hampstead Road. Overall local journey time

validation is better in all three time periods, especially in the PM time period, compared to the full area model.

Table 12: Top line statistics – CLoHAM local Euston area AM peak

Criteria	Full area CLoHAM updated for HS2 TA	Local area CLoHAM updated for HS2 TA	TfL aspiration
Links - GEH <7.5	90%	85%	85%
Links - DMRB flow criteria	85%	79%	85%
Screenline - flow <5%	70%	80%	85%
Journey times - flow difference <15%	63%	63%	85%

Table 13: Top line statistics – CLoHAM local Euston area IP

Criteria	Full area CLoHAM updated for HS2 TA	Local area CLoHAM updated for HS2 TA	TfL aspiration
Links - GEH <7.5	91%	91%	85%
Links - DMRB flow criteria	88%	83%	85%
Screenline - flow <5%	73%	90%	85%
Journey times - flow difference <15%	63%	63%	85%

Table 14: Top line statistics – CLoHAM local Euston area PM peak

Criteria	Full area CLoHAM updated for HS2 TA	Local area CLoHAM updated for HS2 TA	TfL aspiration
Links - GEH <7.5	89%	83%	85%
Links - DMRB flow criteria	86%	81%	85%
Screenline - flow <5%	63%	60%	85%
Journey times - flow difference <15%	63%	63%	85%

7.2.4 The 2012 screenlines were examined and a number of shorter mini-screenlines selected to investigate model performance in the local Euston area. The performance of the screenlines is set out in Table 15, Table 16 and Table 17. In general terms, modelled flows are lower than the corresponding observed flows (also supported by the quicker journey times). Model performance is reasonable in the AM and IP periods, with 80% and 90% of modelled screenlines flows being within 5% of the observed for the AM and IP periods respectively. However, this drops to 60% in the PM peak.

Table 15: AM peak local screenline performance

Screenline	Direction	Observed (PCU)	Modelled (PCU)	% Diff
Central East-West	NB	6,922	7,017	1%
	SB	6,794	6,228	-8%
Central – North	NB	4,187	3,994	-5%
	SB	8,130	7,369	-9%

Screenline	Direction	Observed (PCU)	Modelled (PCU)	% Diff
Northern	EB	3,195	3,304	3%
	WB	4,242	4,128	-3%
Great North South	EB	2,413	2,319	-4%
	WB	2,928	2,829	-3%
Radial - Westminster	EB	5,086	4,939	-3%
	WB	4,683	4,520	-3%

Table 16: IP local screenline performance

Screenline	Direction	Observed (PCU)	Modelled (PCU)	% Diff
Central East-West	NB	7,190	7,111	-1%
	SB	7,237	6,889	-5%
Central – North	NB	4,753	4,645	-2%
	SB	3,315	3,260	-2%
Northern	EB	3,223	3,252	1%
	WB	3,315	3,260	-2%
Great North South	EB	2,278	2,185	-4%
	WB	2,621	2,624	0%
Radial - Westminster	EB	4,913	4,384	-11%
	WB	4,914	4,919	0%

Table 17: PM peak local screenline performance

Screenline	Direction	Observed (PCU)	Modelled (PCU)	% Diff
Central East-West	NB	7,489	7,443	-1%
	SB	7,828	7,795	0%
Central – North	NB	6,020	5,707	-5%
	SB	5,113	4,840	-5%
Northern	EB	4,037	3,758	-7%
	WB	3,445	3,483	1%
Great North South	EB	2,757	2,587	-6%
	WB	2,764	2,550	-8%
Radial - Westminster	EB	5,103	4,251	-17%
	WB	5,108	4,869	-5%

7.2.5 In order to investigate journey times in more detail, a comparison between CLoHAM, Trafficmaster and the June/July 2012 journey time MCOs was undertaken. This highlights the variability in the observed data where the difference between

Trafficmaster and MCO is often greater than the difference between CLoHAM and Trafficmaster.

8 Model convergence

8.1.1 Model convergence is required in order to provide stable, consistent and robust model results and to differentiate between real changes and those associated with differing degrees of convergence.

8.1.2 WebTAG provides guidance on model convergence with recommendations on acceptable variations in link flows and costs between iterations helping to ensure the model is sufficiently stable. This is set out in Table 18.

Table 18: Summary of convergence measures and base model acceptable values

Measures of convergence	Acceptability guidelines
Delta and %GAP	Less than 0.1% or at least stable with convergence fully documented and all other criteria met
Percentage of links with flow change (P) <1%	Four consecutive iterations greater than 98%
Percentage of links with cost change (P2) <1%	Four consecutive iterations greater than 98%
Percentage change in total user costs of links with flow change (V) <1%	Four consecutive iterations less than 0.1% (SUE only)

Source: TAG UNIT 3.19, May 2012

8.1.3 Convergence parameters have not been altered from those set in CLoHAM Production Version 1. The outer loop convergence criteria have been set to stop the procedure when 100% of links (SATURN parameter ISTOP) change their flow or delay by less than 3% (SATURN parameter PCNEAR) compared to the previous iteration. These criteria must be met on four consecutive iterations. A summary of the convergence statistics is given in Table 19.

Table 19: Model convergence statistics

Convergence statistic	AM % flows	AM % delays	IP % flows	IP % delays	PM % flows	PM % delays
Flow change final iteration	98.2	98.6	98.9	98.8	98.8	98.9
Flow change final iteration -1	98.9	98.8	99.1	98.8	99.0	98.8
Flow change final iteration -2	97.8	98.2	98.9	98.9	98.2	98.5
Flow change final iteration -3	98.3	98.3	99.0	98.9	98.6	98.6
%Gap		0.031%		0.030%		0.028%

8.1.4 The %Gap in all time periods is less than 1%. The percentages of links with flow changes less than 1% in the last four iterations are within 98% for all models. As such the models are considered to have converged and are stable.

9 Performance in forecast mode

9.1.1 CLoHAM has been run for the 2021 future baseline and future baseline plus construction and 2026/2041 future baseline and future baseline plus operation. These runs have included:

- future year demand matrices provided by TfL and based on the change in LTS demand between the base year and relevant forecast year, applied to the final base year calibrated CLoHAM matrices;
- signal optimisation for the relevant forecast years based on files provided by TfL;
- committed highway schemes for the relevant forecast years;
- scheme details for construction in terms of road closures and traffic interventions, HGV volumes and routes for construction; and
- scheme details for operation in terms of permanent highway interventions, taxi operations, servicing and delivery and highway access arrangements.

9.1.2 Results from these models have been reviewed and found to give plausible results in terms of:

- overall changes to traffic volumes and junction delays between the 2012 base year and relevant future baseline; and
- changes to general traffic, HGVs and taxi flows between the future baseline and future baseline plus construction/operation.

10 Conclusions

10.1.1 This model performance report sets out the performance of the CLoHAM model revised for the HS2 TA. The model has been updated from 2009 to 2012 using traffic count data provided by TfL.

10.1.2 Model performance has been examined at a model-wide level and at a more local level.

10.1.3 At the model-wide level, the revised model shows significant improvements against the headline statistics required by TfL in their 'Dashboard' analysis, namely, links with a GEH less than 7.5, links meeting DMRB's flow criteria of screenline flow within 5% and screenline GEH less than four and journey times within 15%. The largest improvement is for screenlines within 5% which improves markedly by 17%, 12% and 10% for the AM, IP and PM peaks respectively.

10.1.4 Overall link calibration improves in all cases whilst journey time validation is similar or better than for the 2009 model. It should be noted that a different dataset (Trafficmaster versus MCO data) has been used for journey time validation using an approach not used for other HAMs to date.

10.1.5 At the local level, the report sets out link performance, screenline performance and journey time performance. Link performance is slightly worse than at the model-wide level but links with a GEH less than 7.5 are still near or above 85%. Screenline performance is judged to be acceptable in the AM and IP periods, with 80% and 90% of modelled screenline flows being within 5% of the observed for the AM and IP periods respectively. This drops to 70% for the PM peak.

10.1.6 Finally, model convergence meets DMRB guidelines and, as such, the models are considered to have converged and are stable.

10.1.7 In conclusion, at both the model wide and local levels, the revised CLoHAM is considered appropriate for assessing the construction and operational effects of HS2 on the highway network.

Annex C(iii) - WeLHAM Model Performance Report

This annex contains the West London Highway Assignment Model (WeLHAM) Model Performance Report. It provides an overview of the recalibration that was undertaken of an existing WeLHAM model for the Old Oak Common and West Ruislip areas in order to inform the construction and operational impacts on the wider highway network of the Proposed Scheme.

HS2 WeLHAM OOC Baseline Model Performance Report

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List of acronyms

ATC	Automatic Traffic Counts
C221	London Metropolitan Preliminary Design Contract
HS2	High Speed 2
IP	Inter Peak
MCC	Manual Classified Counts
ME	Matrix Estimation
MPR	Model Performance Report
OAPF	Opportunity Area Planning Framework
OOC	Old Oak Common
TfL	Transport for London
WeLHAM	West London Highway Assignment Model

1 Introduction

1.1.1 The implementation of High Speed 2 (HS2) in West London is anticipated to primarily impact on traffic flows in the areas around Old Oak Common (OOC) and West Ruislip. The section between these two locations will be tunnelled thereby minimising potential construction impacts and traffic disruptions. Traffic effects will be most significant at either end of the tunnel; the Old Oak Common area will be affected both during construction and on completion of the scheme and West Ruislip will primarily be affected during construction. Accordingly, the traffic modelling was focused on these two local study areas, following liaison with Transport for London (TfL).

1.1.2 The SATURN West London Highway Assignment Model (WeLHAM) developed by TfL covers the area from Old Oak Common (OOC) westwards up to the M25 and provides an appropriate basis for the strategic assessment of traffic interventions and operational effects.

1.1.3 The purpose of this Model Performance Report (MPR) is to provide an overview of the recalibration that was undertaken in the two study local areas in order to inform the construction and operational impacts on the wider highway network and associated environmental effects. This MPR will refer to three versions of the TfL WeLHAM base model one of which has been further developed for the purpose of assessing the effects of HS2. Table 1.1 gives a brief overview of these models.

Table 1.1 WeLHAM Model Version Overview

Model Reference	2009 WeLHAM	(OAPF) 2009 WeLHAM OOC	(HS2) 2012 WeLHAM OOC
Developer	TfL	TfL/URS	TfL/MML (C221)
Study Area(s)	West London	OOC OAPF 2km boundary	OOC Station 1km boundary, West Ruislip/Ickenham
ME/Validation Counts Year	2009	2009	2012
Peak Periods	AM PH, Inter Peak, PM PH	AM PH, PM PH	AM PH, PM PH

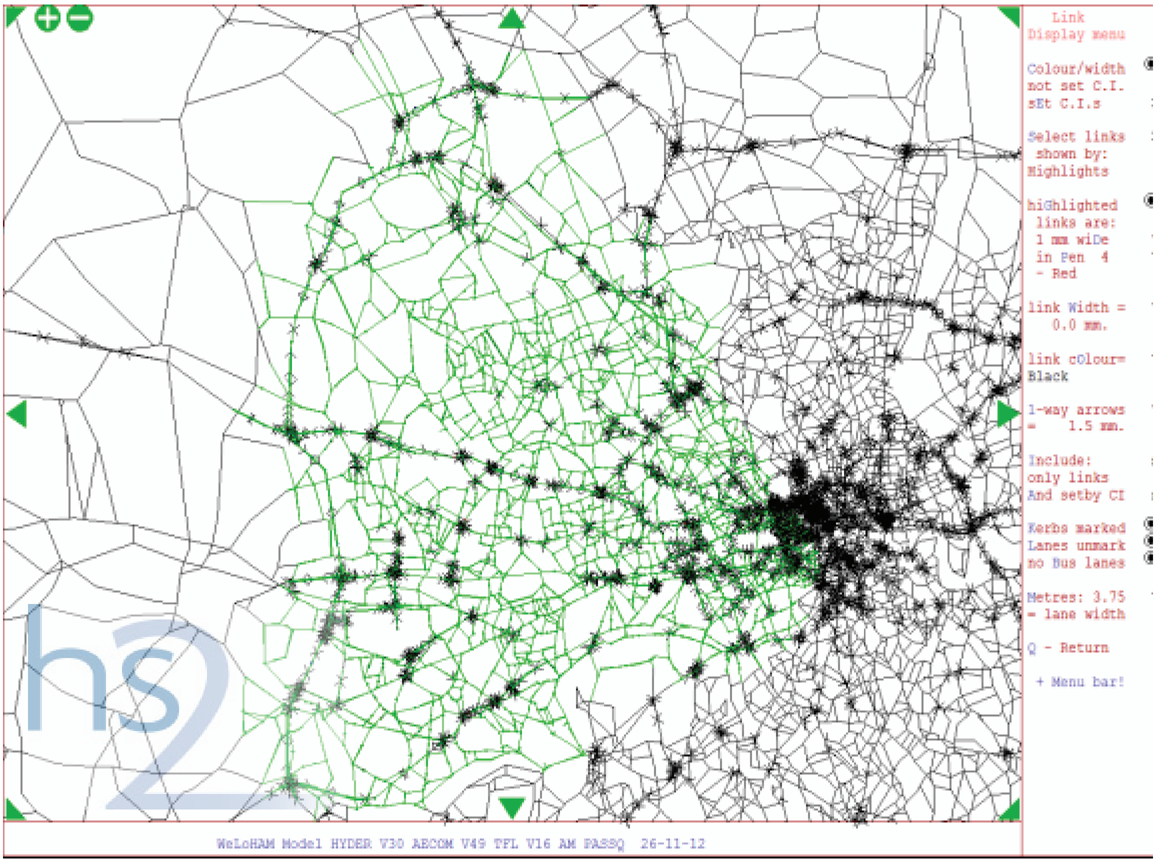
1.1.4 The 2009 WeLHAM Base Model was modified by URS on behalf of TfL in the first half of 2013 for the purpose of assessing the traffic impacts of the proposed Park Royal Opportunity Area Planning Framework (OAPF) to produce 2009 WeLHAM OOC model. The network modifications and post matrix estimation validation results will be discussed briefly as they are relevant to the update process undertaken by C221.

1.1.5 Appendix A contains a factsheet that describes the basic model parameters for 2012 WeLHAM OOC and files used in the modelling process.

1.1.6 Figure 1.1 shows the full extent of the WeLHAM model. The links in green represents the core modelled network. It is comprised of West London and parts of Northwest and Southwest London up to the M25, M1 (North) and the

M3 (South). The network density is significant around the Central London area but decreases steadily when going westwards.

Figure 1.1 SATURN WeLHAM Network



1.2 Study Areas

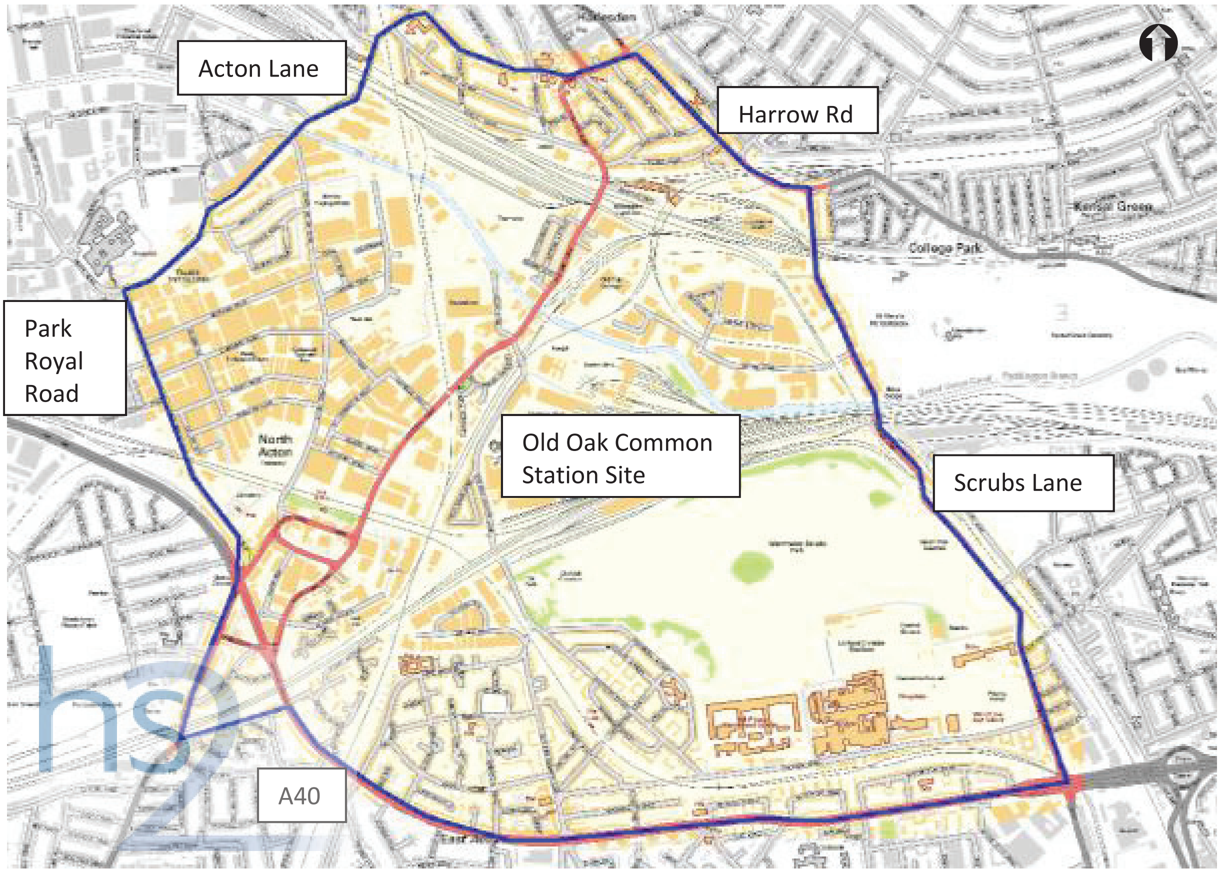
1.2.1 As mentioned in the previous section, the local recalibration of the 2009 WeLHAM OOC Model has focused on the following two local study areas:

- Old Oak Common (OOC)
- West Ruislip

1.2.2 It is expected that on completion of HS2 construction at all locations except OOC, the highway network will effectively revert to the pre-HS2 network layout. Certain road sections in the West Ruislip area may also be subject to minor alterations which do not affect capacity.

1.2.3 Due to the geographic distance between these areas combined impacts are not anticipated and it is therefore appropriate to carry out the comparison for the local study areas separately. Figure 1.2 shows OOC, the first core study area. The proposed OOC Station is in the centre of the study area. It is encompassed by Scrubs Lane in the East, the A40 in the south, Park Royal Road/Acton Lane in the West and the A404/Harrow Road in the north.

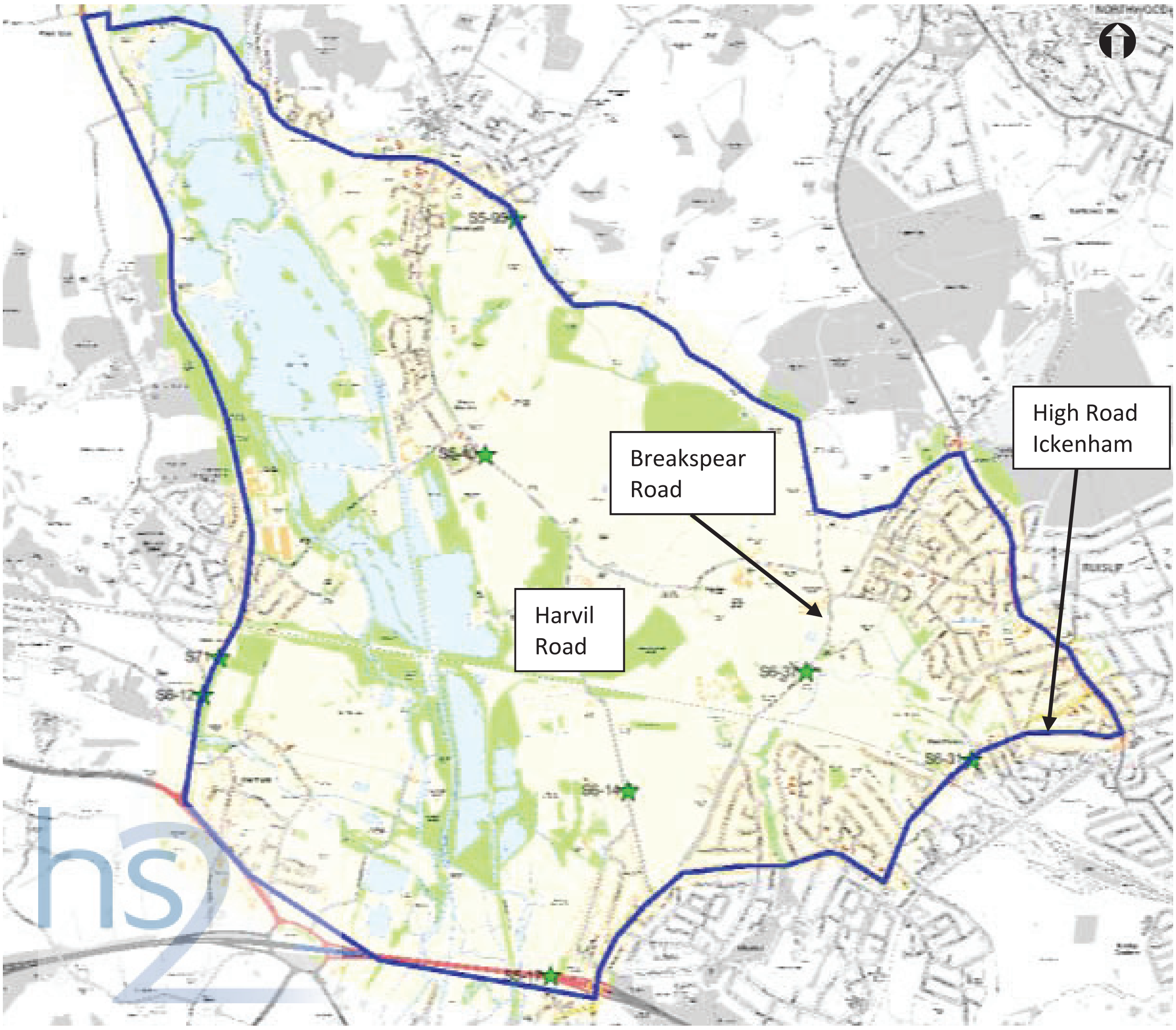
Figure 1.2 Overview of Core Study Areas - OOC



Source: Contains Ordnance Survey Data, 2012

1.2.4 Figure 1.3 shows the extent of the West Ruislip core study area. It extends from Swakeleys Road/High Road Ickenham/Bury Street in the East to North Orbital Road/Denham Drive in the West and from the A40 in the South to Breakspear Road/Park Lane in the North.

Figure 1.3 Overview of Core Study Areas – West Ruislip



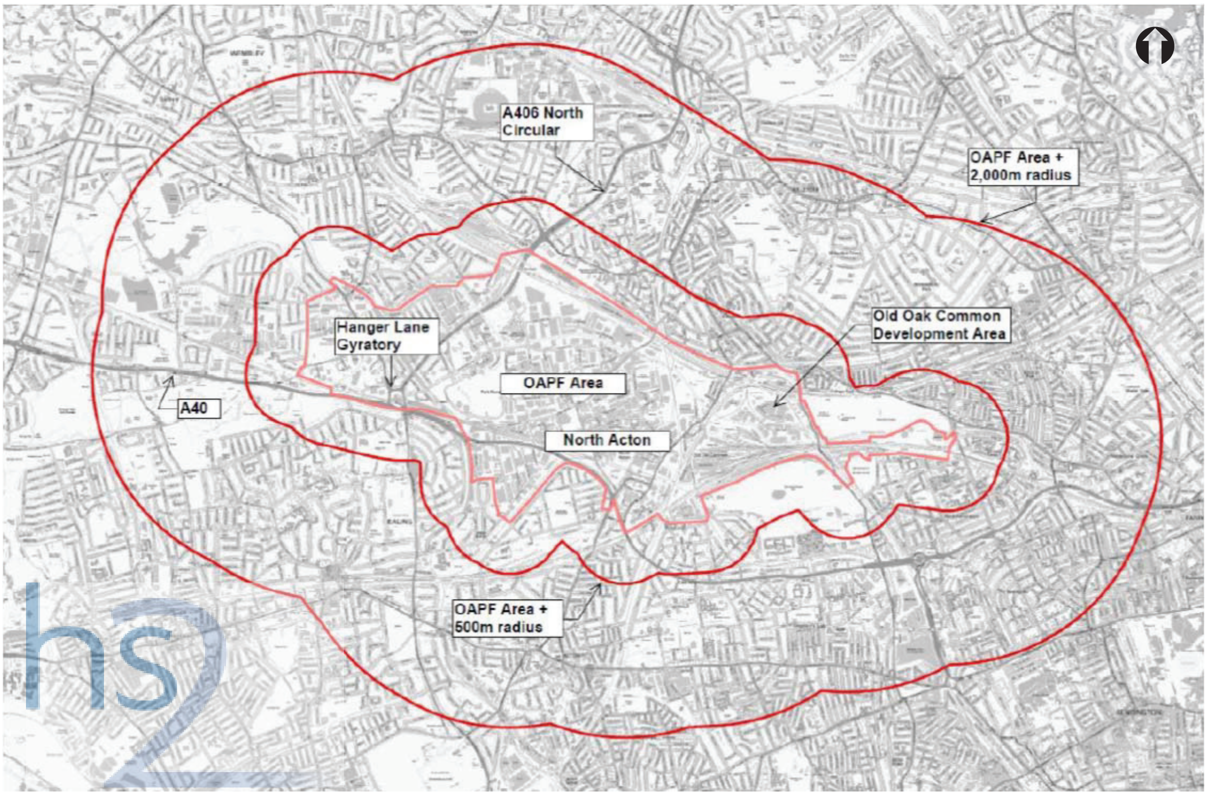
Source: Contains Ordnance Survey Data, 2012; TfL Count Location GIS Layer

1.3 2009 WeLHAM OOC Model

1.3.1 The 2009 WeLHAM OOC base model that was provided by TfL to HS2 for the current Transport Assessment work differed substantially from the 2009 WeLHAM base model upon which the previous draft HS2 Transport Assessment (March 2013) was based. The 2009 WeLHAM OOC base model comprises a recalibrated version of the 2009 WeLHAM base model using additional 2009 survey data and an expanded zone system in order to increase the level of validation in the OOC area and enable future year developments to be readily considered.

1.3.2 Figure 1.4 shows the extent of the local re-calibration that was undertaken. Compared to the C221 local recalibration area which was presented in the previous section, the 2009 WeLHAM OOC model was recalibrated over a wider area that included Hanger Lane Gyratory.

Figure 1.4 2009 WeLHAM OOC Local Recalibration Area

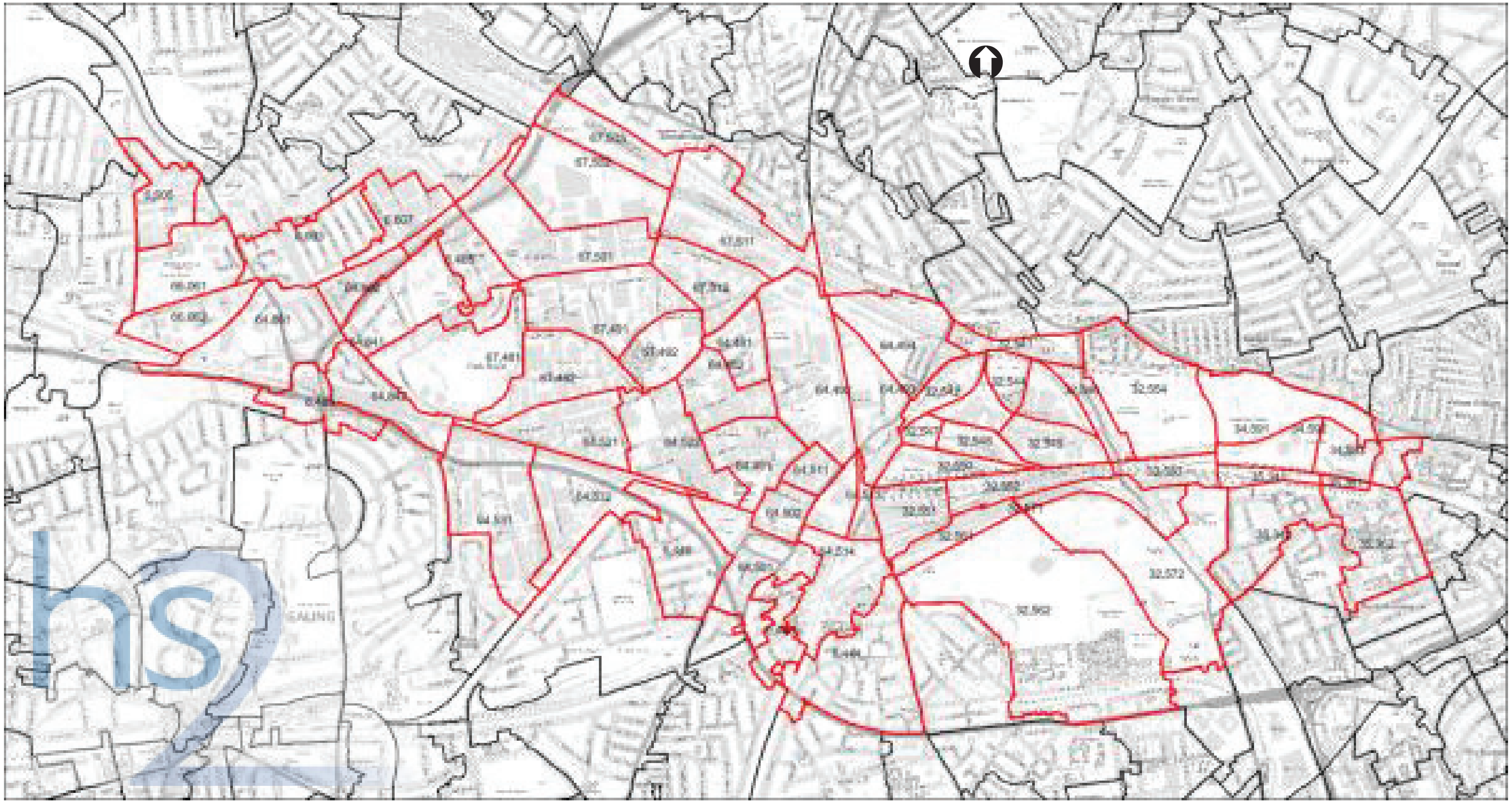


Source: URS WeLHAM Local Highway Model Calibration Report Rev3

1.4 WeLHAM OOC Zoning System

1.4.1 The 2009 WeLHAM model consists of 1,779 zones. The zonal system was expanded in the 2009 WeLHAM OOC Model for the purpose of assessing the impact of the proposed OAPF in the Park Royal and OOC areas. This model increased the number of zones by 37 to 1,816. Figure 1.3 shows the expanded zonal system around OOC.

Figure 1.5 2009 WeLHAM OOC Model Zones OOC Area



Source: Contains Ordnance Survey Data, 2012, Zone GIS Layers provided by TfL (09/04/2013)

2 Traffic Data

2.1 Purpose of Traffic Surveys

2.1.1 A significant number of surveys were undertaken by C221 over the period June 2012 to July 2012 as well as October 2012 in the West London area along the HS2 corridor. These surveys captured traffic and pedestrian movements around the proposed HS2 intervention sites as well as on the surrounding road network.

2.1.2 These surveys enabled the comparison between the TfL 2009 WeLHAM OOC Model flows and 2012 observed flows in the OOC study area. A selection of 2012 counts was also used as input to Matrix Estimation (ME) and summarised in 0. These were in addition to the earlier TfL count database.

2.1.3 C221 survey locations were selected based on areas in close proximity to interventions and construction worksites and took into consideration locations where TfL data existed. In order to avoid undertaking the surveys during the closure of the Hammersmith Flyover and during the 2012 Olympic Games a period in the early summer was chosen.

2.1.4 Appendix C provides the location of all survey sites used for the 2012 WeLHAM OOC comparison and calibration.

2.1.5 Additional 2012 survey information was received from TfL for the two study areas. As it was not feasible for C221 to collect comprehensive survey data in the London Borough of Hillingdon, the TfL surveys in this area provided the most reliable source of information in terms of traffic flows on major roads.

2.2 Types of Surveys

2.2.1 Two types of traffic surveys were undertaken which are relevant for the comparison and validation process:

- Automatic Traffic Counts (ATCs)
- Manual Classified Counts (MCCs)

2.2.2 The ATC and MCC counts were processed for the input and comparison with modelled flows. In addition to the ATC and MCC surveys, associated surveys for broader Transport Assessment purposes were also undertaken by C221 for

- journey time,
- pedestrian and
- parking occupancy.

2.3 Automatic Traffic Counts

2.3.1 ATCs were collected in 2012 for up to two weeks per survey site to record speed and vehicle class data and link traffic volumes along the highway routes. A total of 17 sites were used for ME and model validation. As indicated above TfL ATC information was also used for calibration and validation purposes.

2.3.2 A comparison of vehicle splits between ATC and MCC data around the two study areas showed that the split of cars and LGVs appeared to be inconsistent at comparable sites. As the split of LGVs in the ATC data appeared to be too high, it was adjusted based on the split of cars and LGVs derived from MCC data which is likely to be a more reliable indicator of the vehicle splits.

2.4 Manual Traffic Counts

2.4.1 The MCCs used are fully classified traffic count data surveys undertaken at highway junctions, to identify the existing traffic demand and turning profiles at the key junctions. Modelled flows were compared to MCC data on a link flow basis.

2.4.2 The majority of TfL MCCs are multi-day counts and could therefore be used for model calibration as well as validation.

2.5 Count Comparison

2.5.1 So as to ensure that the various count datasets are consistent and appropriately used a check was undertaken to a) test consistency between C221 and TfL counts and b) determine which counts should be used for local recalibration. This process predominantly applied to the OOC area as C221 was prevented from undertaking the majority of surveys around West Ruislip.

2.6 Journey Times

2.6.1 TrafficMaster data was provided by TfL for the purpose of journey time analysis. Two datasets were provided: Annualised journey time data and peak hour journey time data. TfL recommended utilising the peak hour data when validating the modelled journey times.

2.6.2 The peak hour data was provided in monthly format for three months in 2011 (Sept-Nov) and a single month in 2012 (Mar). TfL indicated that the March 2012 dataset may be skewed by the closure of the Hammersmith Flyover in advance of the 2012 Olympics. Therefore, November 2011 data was used for validation purposes in liaison with TfL.

3 2009 WELHAM OOC Model Review

3.1 2009 WELHAM OOC Model – Observed Data Comparison

3.1.1 Comparisons were undertaken to determine how well the 2009 WeLHAM OOC model validates in the two study areas.

3.1.2 The Design Manual for Roads and Bridges (DMRB, Volume 2 Section 2) states that there are two principle statistics to determine the difference between model and observed traffic flows:

- GEH statistic
- Modelled divided by observed flows (% difference criteria)

3.1.3 The GEH statistic is a measure to determine the goodness of fit between modelled and observed flows. It is a form of Chi-squared statistic that incorporates both relative and absolute errors between the two sets of data and is based on the following equation:

$$\boldsymbol{GEH} = \sqrt{\frac{(\boldsymbol{M}-\boldsymbol{C})^2}{\frac{(\boldsymbol{M}+\boldsymbol{C})}{\boldsymbol{2}}}}$$

GEH	GEH statistic
M	Modelled Flow
C	Observed Flow

3.1.4 A GEH value of less than 5 is deemed to be acceptable by the DMRB. This is equivalent of a 95% confidence level. The validation acceptability guidance states that this condition must be met in greater than 85% of cases.

3.1.5 The second method divides model flows by observed flows and the result is assessed against the criteria in the table below. The validation acceptability guidance is also that the conditions should be met in greater than 85% of cases. However, the DMRB also states that models which fall short of meeting these criteria may still be acceptable as long as the links with the largest discrepancies are located outside the immediate area of interest.

Calibration and Validation Criteria

Observed Flows (vehicles per hour)	Criteria
700 to 2700	Individual flows within 15%
<700	Individual flows within 100 vph
>2700	Individual flows witin 400 vph
All Flows	GEH Statistic <5

3.1.6 Since this report is a Model Performance Report and not a formal Local Model Validation Report, these criteria will be used as guidance to assess the robustness of the model.

3.1.7

3.1.8 Table 3.2 compares the flow validation of the 2009 WeLHAM AM model and 2009 WeLHAM OOC AM model for the TfL screenlines using 2009 observed data. Where a direct comparison is possible, the 2012 data is also shown. The level of validation has increased substantially both in the OOC study area as well on the surrounding screenlines. Appendix D provides a diagram of the TfL screenline locations for WeLHAM.

3.1.9 The number of locations with GEH less than 5 has increased from 43% to 67% and the number of locations with GEH less than 7.5 has improved by increasing from 63% to 86%. At certain locations, however, such as on Old Oak Common Lane (EW Inner NB/SB) and A4000 Victoria Road NB/SB which are key routes within the HS2 study areas, the model is less robust.

3.1.10 Table 3.3 shows the comparison between the 2009 WeLHAM PM model and the 2009 WeLHAM OOC PM model. Similar to the AM model, the level of validation has also improved in the PM model from 59% of locations with a GEH of less than 5 to 67% and 71% of locations with a GEH of less than 7.5 to 86%. There are similar weaknesses regarding the robustness of the model along key routes such as Old Oak Common Lane NB and A4000/Victoria Road SB.

3.1.11 Table 3.4 shows a comparison between 2009 WeLHAM OOC base model and 2012 observed traffic flows for the West Ruislip area. This comparison was only possible using 2012 counts so it is assumed that flows have not changed substantially. It is evident that a number of locations have a GEH greater than 7.5.

Table 3.2 AM 2009 WeLHAM – AM 2009 WeLHAM OOC Comparison (OOC Area)

Site description	A node	B node	Observed 2009	Observed 2012	Traffic flows in PCU: AM 08:00-09:00 — 2009 WeLHAM Base Model: Model	Diff. 2009	% Diff. 2009	GEH	2009 WeLHAM OOC Base Model: Model	Diff. 2009	% Diff. 2009	GEH
A40 W of A4000 e/b	64385	64386	2,990	3,068	2,272	-718	-24	14.00	2,568	-422	-14	8.01
A40 E of A4000 w/b	64342	64341	2,379	2,645	2,451	72	3	1.47	2,307	-72	-3	1.49
A40 E of HLG e/b	64156	64359	924	-	356	-568	-61	22.45	980	56	6	1.81
A40 E of HLG w/b	64095	64156	1,054	-	1,078	24	2	0.74	829	-225	-21	7.33
A40 W of HLG e/b	64023	64211	1,697	-	1,767	70	4	1.68	1,886	189	11	4.47
A40 W of HLG w/b	64368	64383	2,034	-	1,437	-597	-29	14.33	2,071	37	2	0.82
A4000 Victoria Rd n/b	64101	64635	342	361	252	-90	-26	5.22	458	116	34	5.80
A4000 Victoria Rd s/b	64635	64101	463	495	716	253	55	10.42	627	164	35	7.02
A406 between Abbey Rd/A404 n/b	66156	66155	3,680	-	3,379	-301	-8	5.07	3,697	17	0	0.28
A406 between Abbey Rd/A404 s/b	66155	66156	3,545	-	3,032	-513	-14	8.95	3,573	28	1	0.47
A406 N of A404 Jnc. n/b	66154	66077	3,181	-	3,691	510	16	8.70	3,574	393	12	6.76
A406 N of A404 Jnc. s/b	66077	66154	3,220	-	2,827	-393	-12	7.15	3,217	-3	0	0.05
A406 N of HLG n/b	64124	64407	3,049	-	3,120	71	2	1.28	3,255	206	7	3.67
A406 N of HLG s/b	64407	64124	3,080	-	2,217	-863	-28	16.77	2,962	-118	-4	2.15
B4492 Park Royal Rd n/b	64099	64632	448	393	305	-143	-32	7.37	398	-50	-11	2.43
B4492 Park Royal Rd s/b	64632	64099	406	396	77	-329	-81	21.17	433	27	7	1.32
Chase Rd n/b	64100	65092	301	286	295	-6	-2	0.35	228	-73	-24	4.49
Chase Rd s/b	65092	64100	374	338	313	-61	-16	3.29	466	92	25	4.49
Hanger Lane N of HLG n/b	64157	64122	925	-	829	-96	-10	3.24	874	-51	-6	1.70
Hanger Lane N of HLG s/b	64122	64157	1,288	-	1,189	-99	-8	2.81	1,355	67	5	1.84
Hanger Lane S of HLG n/b	64133	64156	1,554	-	1,340	-214	-14	5.63	2,066	512	33	12.03
Hanger Lane S of HLG s/b	64156	64133	1,796	-	1,761	-35	-2	0.83	1,946	150	8	3.47
Twyford Abbey Rd ne/b	64123	66009	153	-	291	138	90	9.26	219	66	43	4.84
Twyford Abbey Rd sw/b	66009	64123	199	-	337	138	69	8.43	246	47	24	3.15
Wales Farm Rd s/b	65101	64097	1,693	1,299	1,178	-515	-30	13.59	1,873	180	11	4.26
RSI Inner EB: A40 Western Av nr Alperton Ln	64093	64023	3,800	-	3,752	-48	-1	0.78	3,923	123	3	1.98
RSI Inner WB: A40 Western Av nr Alperton Ln	64021	64155	3,180	-	2,635	-545	-17	10.11	3,274	94	3	1.65
EW Inner NB: Hanger Ln S of Queens Dr	64125	64063	1,155	-	1,219	64	6	1.86	1,436	281	24	7.81
EW Inner SB: Hanger Ln S of Queens Dr	64063	64125	960	-	1,174	214	22	6.55	1,157	197	21	6.06
Wembley I/B Enc: Harrow Rd NW of A406 Jnc nw/b	66435	66510	853	-	865	12	1	0.41	947	94	11	3.13
Wembley O/B Enc: Harrow Rd NW of A406 Jnc se/b	66510	66435	1,076	-	948	-128	-12	4.02	932	-144	-13	4.54
Val EW2 NB: Abbey Rd N of Cumberland Av	66388	66448	454	-	511	57	13	2.59	489	35	8	1.61
Val EW2 SB: Abbey Rd N of Cumberland Av	66448	66388	682	-	229	-453	-66	21.23	761	79	12	2.94
NS Inner Central EB: A404 Craven Park W of A407 Jnc	66148	66147	668	-	318	-350	-52	15.76	264	-404	-60	18.71
NS Inner Central WB: A404 Craven Park W of A407 Jnc	66147	66148	1,013	-	1,014	1	0	0.03	977	-36	-4	1.14
NS Inner Central EB: Acton Ln N of Mordaunt Rd Jnc	66137	66452	432	-	493	61	14	2.84	434	2	0	0.10
NS Inner Central EB: Acton Ln N of Mordaunt Rd Jnc	66452	66137	382	-	369	-13	-3	0.67	368	-14	-4	0.72
Val EW2 NB: A4000 Station Rd S of Tubbs Rd	64235	66211	394	414	400	6	2	0.30	535	141	36	6.54
Val EW2 SB: A4000 Station Rd S of Tubbs Rd	66211	64235	793	633	839	46	6	1.61	852	59	7	2.06
Val EW2 NB: A404 Harrow Rd W of Scrubs Ln	66205	66025	629	-	658	29	5	1.14	633	4	1	0.16
Val EW2 SB: A404 Harrow Rd W of Scrubs Ln	66025	66205	1,077	-	814	-263	-24	8.55	890	-187	-17	5.96
EW Inner NB: Scrubs Ln at Mitre Bridge	32167	32094	590	529	719	129	22	5.04	726	136	23	5.30
EW Inner SB: Scrubs Ln at Mitre Bridge	32094	32167	633	776	823	190	30	7.04	695	62	10	2.41
EW Inner NB: Old Oak Common Ln S of A4000	65095	64129	328	276	226	-102	-31	6.13	189	-139	-42	8.65
EW Inner SB: Old Oak Common Ln S of A4000	64129	65095	458	401	201	-257	-56	14.16	242	-216	-47	11.55
EW Inner NB: A4000 Horn Ln S of Noel Rd	64067	64096	1,022	895	737	-285	-28	9.61	721	-301	-29	10.20
EW Inner SB: A4000 Horn Ln S of Noel Rd	64096	64067	582	569	682	100	17	3.98	755	173	30	6.69
NS Mid Outer WB:	64089	64212	4,066	-	3,567	-499	-12	8.08	3,942	-124	-3	1.96
NS Mid Outer EB:	64212	64089	4,729	-	5,208	479	10	6.80	4,663	-66	-1	0.96
						GEH<5:		43%	GEH<5:			67%
						GEH<7.5:		63%	GEH<7.5:			86%

Source: Model data from URS WeLHAM Local Highway Model Calibration Report Rev03

Table 3.3 PM 2009 WeLHAM– PM 2009 WeLHAM OOC Comparison (OOC Area)

Site description	A node	B node	Traffic flows in PCU: PM 17:00-18:00									
			Observed 2009	Observed 2012	2009 WeLHAM Base Model				2009 WeLHAM OOC Base Model			
					Model	Diff. 2009	% Diff. 2009	GEH	Model	Diff. 2009	% Diff. 2009	GEH
A40 W of A4000 e/b	64385	64386	2,276	2,686	2,097	-179	-8	3.83	2,257	-19	-1	0.40
A40 E of A4000 w/b	64342	64341	3,319	3,661	3,248	-71	-2	1.24	3,491	172	5	2.95
A40 E of HLG e/b	64156	64359	596	-	36	-560	-94	31.50	407	-189	-32	8.44
A40 E of HLG w/b	64095	64156	1,138	-	981	-157	-14	4.82	1,059	-79	-7	2.38
A40 W of HLG e/b	64023	64211	1,768	-	1,524	-244	-14	6.01	1,889	121	7	2.83
A40 W of HLG w/b	64368	64383	2,001	-	1,628	-373	-19	8.76	2,117	116	6	2.56
A4000 Victoria Rd n/b	64101	64635	330	354	703	373	113	16.41	279	-51	-15	2.92
A4000 Victoria Rd s/b	64635	64101	491	534	607	116	24	4.95	688	197	40	8.11
A406 between Abbey Rd/A404 n/b	66156	66155	4,511	-	3,385	-1,126	-25	17.92	4,370	-141	-3	2.12
A406 between Abbey Rd/A404 s/b	66155	66156	3,408	-	3,197	-211	-6	3.67	3,193	-215	-6	3.74
A406 N of A404 Jnc. n/b	66154	66077	4,335	-	4,176	-159	-4	2.44	4,660	325	7	4.85
A406 N of A404 Jnc. s/b	66077	66154	3,273	-	3,332	59	2	1.03	3,186	-87	-3	1.53
A406 N of HLG n/b	64124	64407	3,297	-	2,856	-441	-13	7.95	3,477	180	5	3.09
A406 N of HLG s/b	64407	64124	2,735	-	2,735	0	0	0.00	2,513	-222	-8	4.33
B4492 Park Royal Rd n/b	64099	64632	563	351	316	-247	-44	11.78	444	-119	-21	5.30
B4492 Park Royal Rd s/b	64632	64099	326	519	316	-10	-3	0.56	574	248	76	11.69
Chase Rd n/b	64100	65092	223	211	336	113	51	6.76	126	-97	-43	7.34
Chase Rd s/b	65092	64100	440	423	312	-128	-29	6.60	431	-9	-2	0.43
Hanger Lane N of HLG n/b	64157	64122	980	-	964	-16	-2	0.51	1,043	63	6	1.98
Hanger Lane N of HLG s/b	64122	64157	1,222	-	1,064	-158	-13	4.67	1,437	215	18	5.90
Hanger Lane S of HLG n/b	64133	64156	1,327	-	1,205	-122	-9	3.43	1,618	291	22	7.58
Hanger Lane S of HLG s/b	64156	64133	1,477	-	1,850	373	25	9.15	1,586	109	7	2.79
Twyford Abbey Rd ne/b	64123	66009	97	-	70	-27	-28	2.95	143	46	47	4.20
Twyford Abbey Rd sw/b	66009	64123	246	-	260	14	6	0.88	305	59	24	3.55
Wales Farm Rd s/b	65101	64097	2,100	1,164	1,569	-531	-25	12.40	1,831	-269	-13	6.07
RSI Inner EB: A40 Western Av nr Alperton Ln	64093	64023	3,500	-	3,011	-489	-14	8.57	3,528	28	1	0.47
RSI Inner WB: A40 Western Av nr Alperton Ln	64021	64155	4,200	-	4,008	-192	-5	3.00	4,516	316	8	4.79
EW Inner NB: Hanger Ln S of Queens Dr	64125	64063	1,125	-	1,229	104	9	3.03	1,503	378	34	10.43
EW Inner SB: Hanger Ln S of Queens Dr	64063	64125	1,185	-	1,452	267	23	7.35	1,397	212	18	5.90
Wembley I/B Enc: Harrow Rd NW of A406 Jnc nw/b	66435	66510	1,039	-	1,104	65	6	1.99	1,108	69	7	2.11
Wembley O/B Enc: Harrow Rd NW of A406 Jnc se/b	66510	66435	916	-	1,005	89	10	2.87	924	8	1	0.26
Val EW2 NB: Abbey Rd N of Cumberland Av	66388	66448	911	-	741	-170	-19	5.92	761	-150	-16	5.19
Val EW2 SB: Abbey Rd N of Cumberland Av	66448	66388	496	-	508	12	2	0.54	572	76	15	3.29
NS Inner Central EB: A404 Craven Park W of A407 Jnc	66148	66147	458	-	374	-84	-18	4.12	364	-94	-21	4.64
NS Inner Central WB: A404 Craven Park W of A407 Jnc	66147	66148	900	-	945	45	5	1.48	915	15	2	0.50
NS Inner Central EB: Acton Ln N of Mordaunt Rd Jnc	66137	66452	503	-	569	66	13	2.85	601	98	19	4.17
NS Inner Central EB: Acton Ln N of Mordaunt Rd Jnc	66452	66137	434	-	433	-1	0	0.05	377	-57	-13	2.83
Val EW2 NB: A4000 Station Rd S of Tubbs Rd	64235	66211	712	578	703	-9	-1	0.34	714	2	0	0.07
Val EW2 SB: A4000 Station Rd S of Tubbs Rd	66211	64235	431	429	607	176	41	7.73	562	131	30	5.88
Val EW2 NB: A404 Harrow Rd W of Scrubs Ln	66205	66025	705	-	730	25	4	0.93	707	2	0	0.08
Val EW2 SB: A404 Harrow Rd W of Scrubs Ln	66025	66205	789	-	766	-23	-3	0.82	788	-1	0	0.04
EW Inner NB: Scrubs Ln at Mitre Bridge	32167	32094	938	909	1,066	128	14	4.04	1,104	166	18	5.20
EW Inner SB: Scrubs Ln at Mitre Bridge	32094	32167	606	601	739	133	22	5.13	716	110	18	4.28
EW Inner NB: Old Oak Common Ln S of A4000	65095	64129	604	469	432	-172	-28	7.56	450	-154	-25	6.71
EW Inner SB: Old Oak Common Ln S of A4000	64129	65095	247	273	133	-114	-46	8.27	182	-65	-26	4.44
EW Inner NB: A4000 Horn Ln S of Noel Rd	64067	64096	993	964	610	-383	-39	13.53	582	-411	-41	14.65
EW Inner SB: A4000 Horn Ln S of Noel Rd	64096	64067	632	580	395	-237	-38	10.46	409	-223	-35	9.77
NS Mid Outer WB:	64089	64212	5,254	-	4,913	341	-6	4.78	5,323	69	1	0.95
NS Mid Outer EB:	64212	64089	4,355	-	4,598	243	6	3.63	4,502	147	3	2.21
						GEH<5:		59%	GEH<5:			67%
						GEH<7.5:		71%	GEH<7.5:			86%

Source: Model data from URS WeLHAM Local Highway Model Calibration Report Rev03

3.1.12 The flows on Breakspear Road North in particular appear to be significantly lower compared to the survey counts and a typical traffic flow on this type of road.

Table 3.4 AM 2009 WeLHAM OOC Comparison to 2012 Observed (West Ruislip Area)

Site description	A node	B node	Traffic flows in PCU: AM 08:00-09:00					
			Observed 2012	2009 WeLHAM OOC Base Model				
				Model	Diff. 2012	% Diff. 2012	GEH
A412 North Orbital Road, Denham Green n/b	91890	91506	786	1,150	363	46	11.7
A412 North Orbital Road, Denham Green s/b	91506	91890	1,084	1,374	290	27	8.3
Western Avenue, filmed from the B467 RBT e/b	62233	62321	4,390	4,405	15	0	0.2
Western Avenue, filmed from the B467 RBT w/b	62321	62233	4,113	4,856	743	18	11.1
Harvil Road North n/b	62124	62132	451	588	137	30	6.0
Harvil Road North s/b	62132	62124	431	390	-41	-10	2.0
Harvil Road South n/b	62109	62124	319	366	46	14	2.5
Harvil Road South s/b	62124	62109	502	428	-74	-15	3.4
Breakspear Road North n/b	62156	62141	403	33	-371	-92	25.1
Breakspear Road North s/b	62141	62156	299	31	-269	-90	20.9
Breakspear Road South (Near Rail Bridge) n/b	62110	62123	517	591	74	14	3.2
Breakspear Road South (Near Rail Bridge) s/b	62123	62110	646	733	87	14	3.3
Ickenham Road (BTW West Ruislip Station and Ickenham Close) n/b	62447	62114	819	1,076	258	31	8.4
Ickenham Road (BTW West Ruislip Station and Ickenham Close) s/b	62114	62447	1,113	1,275	161	15	4.7
					GEH<5:		50%
					GEH<7.5:		57%

Source: 2009 WeLHAM OOC Model provided by TfL (09/04/2013)

3.1.13 Table 3.5 shows that the PM 2009 WeLHAM OOC model also appears to validate relatively poorly in West Ruislip. The reduced flows on Breakspear Road North occur in this model as well. The use of 2012 rather than 2009 observed data may account for higher GEH values.

Table 3.5 PM 2009 WeLHAM OOC Comparison to 2012 Observed (West Ruislip Area)

Site description	A node	B node	Traffic flows in PCU: PM 17:00-18:00					
			Observed 2012	2009 WeLHAM OOC Base Model				
				Model	Diff. 2012	% Diff. 2012	GEH
A412 North Orbital Road, Denham Green n/b	91890	91506	916	953	38	4	1.2
A412 North Orbital Road, Denham Green s/b	91506	91890	979	1,143	164	17	5.0
Western Avenue, filmed from the B467 RBT e/b	62233	62321	4,565	4,620	54	1	0.8
Western Avenue, filmed from the B467 RBT w/b	62321	62233	4,660	4,075	-585	-13	8.9
Harvil Road North n/b	62124	62132	358	536	178	50	8.4
Harvil Road North s/b	62132	62124	453	428	-25	-5	1.2
Harvil Road South n/b	62109	62124	296	550	254	86	12.4
Harvil Road South s/b	62124	62109	413	356	-57	-14	2.9
Breakspear Road North n/b	62156	62141	223	18	-205	-92	18.7
Breakspear Road North s/b	62141	62156	316	37	-279	-88	21.0
Breakspear Road South (Near Rail Bridge) n/b	62110	62123	837	802	-36	-4	1.2
Breakspear Road South (Near Rail Bridge) s/b	62123	62110	497	541	44	9	1.9
Ickenham Road (BTW West Ruislip Station and Ickenham Close) n/b	62447	62114	1,109	1,312	203	18	5.8
Ickenham Road (BTW West Ruislip Station and Ickenham Close) s/b	62114	62447	959	1,097	138	14	4.3
					GEH<5:		50%
					GEH<7.5:		64%

Source: 2009 WeLHAM OOC Model provided by TfL (09/04/2013)

3.1.14 There were other weaknesses that were identified when reviewing the model in the West Ruislip area such as the high flows on Newyears Green Lane which is an access road to local industrial estates. It is reduced in width on certain sections and site observations confirmed that the high volume of traffic in the model would not be expected along this link. As a result, it would not be a viable diversion route in the 2021 forecast test case and capacity reducing measures will need to be introduced in order to reduce the traffic flow.

3.2 Comparison 2009 WeLHAM and 2009 WeLHAM OOC Model Conclusion

3.2.1 The comparison between the 2009 WeLHAM Model and 2009 WeLHAM OOC Model shows that substantial improvements were made in the levels of validation in the Old Oak Common study area. However, a small number of weaknesses exist along key traffic routes.

3.2.2 The West Ruislip area on the other hand validates poorly at points and there are some weaknesses in the network that result in unexpectedly high or low flows on certain links.

3.2.3 As a result of this comparison in liaison with TfL, it was appropriate to further improve the 2009 WeLHAM OOC model in the two study areas to form a more solid foundation for the forecast assessments. Matrix estimation and a detailed review of the network were undertaken to address these issues and will be described in the following sections.

4 Matrix Estimation

4.1 Model Matrix Estimation Objectives

4.1.1 The objective of matrix estimation is to improve flow validation along key traffic routes in the two study areas. The process of matrix estimation also provided the opportunity to review the network and add new network detail such that traffic diversion routes can be modelled more accurately.

4.2 Process of Matrix Estimation

4.2.1 The main purpose of Matrix Estimation (ME) is to correct and refine trip patterns in the model such that they more closely match traffic counts using a selected set of observed link flows. The process selectively factors individual matrix cells to achieve a better fit between modelled and observed flows. In order to achieve this, C221 utilised the batch files and Prior Matrices provided by TfL. Several matrix estimation runs need to be undertaken in order to iteratively improve the validation in the study areas.

4.3 Prior Matrix

4.3.1 The Prior Matrix used for the ME process is based the same Prior Matrix that was used for the 2009 WeLHAM OOC Model. The main reason for basing ME on Prior Matrices is that it is not recommended to use a matrix that has already been matrix estimated. Furthermore, the post-ME matrix from the 2009 models included changes using counts which had to be modified. The Prior Matrices included the zonal conversion to 1,816 zones.

4.4 Highway Network Coding

Traffic Signals

4.4.1 The majority of traffic signals remain as coded in the 2009 WeLHAM OOC model. Two signal plans were modified to improve the level of validation:

- A40/Eastbound slip road based on information provided by TfL
- Station Road/Tubbs Road based on information provided by TfL

4.5 Network Improvements

4.5.1 A number of adjustments were made to the network in order to model the two study areas in more detail. The following links were added in the OOC area:

- Gorst Road
- School Road
- Bethune Road
- St. Leonard's Road
- OOC Station nodes at the northern end of Old Oak Common Lane

4.5.2 Other network improvements included modifying junction layouts (OOC Lane/ Du Cane Road, Station Road/Tubbs Road), saturation flows and free flow speeds.

4.5.3 When reviewing the network around West Ruislip it was observed that the flows on Newyears Green Lane appeared to be too high compared to C221 on-site observations along this link. A delay was introduced to reduce the flows and more importantly prevent this route from being used as a viable diversion route in forecast scenarios.

4.5.4 Other network changes in this area included adjusting the free flow speeds on Breakspear Road as unrealistic free flow speeds seemed to have resulted in the low flows along this link and also to adjust the saturation flows along North Orbital Road.

4.5.5 Appendix E contains illustrative SATURN plots showing the added network.

4.6 Post Matrix Estimation Model Convergence

4.6.1 WebTag guidance (Unit 3.19) states that model proximity is measured with Delta and %GAP which should be less than 0.1%, however, it is recommended to aim for a value of less than 0.05% to ensure a more robust model basis. WebTag further states that model stability is measured with %FLOW and the change should be less than 1% for four consecutive iterations greater than 98%.

4.6.2 Table 4.1 shows AM 2012 WeLHAM OOC model convergence statistics. While the Delta and %GAP guidance was met, the model falls short of meeting the %FLOW recommended guidance.

- % FLOW change in Loop 11-14 <1%: Not Achieved
- %GAP <0.1%: Achieved
- %Delta <0.1%: Achieved

Table 4.1 AM 2012 WeLHAM OOC Convergence Statistics

LOOP	Ass. (%)	Sim. (%)	%FLOWS	%DELAYS	%V.I.	%GAP	ASS-HRS	AAD	RAAD (%)
1	0.842/20	0.091/18	0	69.9	0	1.082	820893.7	0	0
2	0.274/20	0.072/12	43.1	82.7	0.274	0.47	812832.8	14.1	2.43
3	0.137/20	0.086/10	57.8	87.3	0.043	0.337	811523.9	7.03	1.22
4	0.104/20	0.065/ 7	66.7	88.9	0.0026	0.218	810736.4	5.32	0.92
11	0.0259/14	0.062/ 7	92.2	95.5	0.00058	0.035	809266.4	1.11	0.19
12	0.0227/20	0.050/ 7	93.8	96	0.0015	0.039	809188.3	0.87	0.15
13	0.0218/20	0.052/ 7	94.5	96.4	0.00011	0.034	809257.5	0.77	0.13
14	0.0198/20	0.043/ 7	95.2	96.5	0.00008	0.035	809212.3	0.73	0.13

4.6.3 Table 4.2 shows the statistics for the PM 2012 WeLHAM OOC model which indicate the same trends as the AM model whereby the %GAP guidance is met but the %FLOW guidance is not achieved.

- % FLOW change in Loop 11-14 <1%: Not Achieved
- %GAP <0.1%: Achieved
- %Delta <0.1%: Achieved

Table 4.2 PM Peak Model Convergence Statistics

LOOP	Ass. (%)	Sim. (%)	%FLOWS	%DELAYS	%V.I.	%GAP	ASS-HRS	AAD	RAAD (%)
1	0.874/20	0.036/51	0	67.7	0	1.358	832201.3	0	0
2	0.392/20	0.054/13	41.5	81	0.266	0.592	824242.9	15.61	2.7
3	0.190/20	0.030/ 7	54	84.5	0.0064	0.433	823088.8	9	1.56
4	0.131/20	0.053/10	62.5	86.9	0.0098	0.298	821206.8	6.32	1.1
11	0.0375/20	0.068/ 7	89.1	94	0.00023	0.049	819521.1	1.52	0.26
12	0.0281/20	0.038/ 7	90.2	94.4	0.00018	0.046	819639.1	1.35	0.24
13	0.0296/20	0.042/ 7	93.2	95.4	0.0029	0.041	819434	0.92	0.16
14	0.0255/20	0.028/ 7	92	95	0.00008	0.036	819409.8	1.12	0.2

KEY

Loop	Assignment/Simulation Loop Number
Ass.	Delta Function (%) / Number of Iterations
Sim.	Final Aver Abs Change In Out Cfp (PCU/Hr) / Number of Iterations
%Flows	Link Flows Differing by <1%
&Delay	Turn Delays Differing by <1%
%V.I.	Variational Inequality - Should be >0
%Gap	Wardrop Equilibrium Gap Function Post Simulation
Ass-Hrs	Total PCU-hr/hr from the Buffer + Simulation Networks
AAD	Average Absolute Difference in Link Flows PCU/hr
RAAD	% Relative Average Absolute Differences in Link Flows

4.6.4 Delta and %GAP are usually the most critical convergence statistics which reflect the stability of the model. Although the %FLOW change statistics do not achieve levels recommended by WebTAG guidance, they are sufficiently high and also no different to earlier source models (2009 WeLHAM models and 2009 WeLHAM OOC models). Therefore, the AM and PM models can be both considered sufficiently robust in terms of their stability.

4.7 Post Matrix Estimation Flow Results

4.7.1 Table 4.3 shows the differences in total trips between the 2009 Prior Matrix, 2009 post ME WeLHAM OOC matrix and the 2012 post ME WeLHAM OOC matrix. The total differences for the AM peak indicate that ME has removed a substantial number of trips from the Prior Matrix.

4.7.2 A comparison between Prior Matrix and 2009 post ME WeLHAM OOC matrix shows that this process had also removed a substantial number of trips although the number of removed trips is lower compared to the 2012 WeLHAM OOC model. The ME process increased the number of trips in the PM peak.

Table 4.3 Prior Matrix and 2012 Matrix Total Comparison

MATRIX	GRAND TOTALS Prior Matrix	GRAND TOTALS 2009 WeLHAM OOC Matrix	GRAND TOTALS 2012 WeLHAM OOC Matrix	Difference Prior Matrix – 2009 OOC WeLHAM	Difference Prior Matrix – 2012 OOC WeLHAM
AM	6,196,191	6,187,405	6,183,756	-8,786	-12,435
PM	6,588,589	6,595,229	6,590,601	6,640	2,013

4.7.3 Table 4.4 shows the final matrix totals by user class and peak model. The comparison by user class with the 2009 Prior Matrix can be found in Appendix F.

Table 4.4 2012 Final ME Matrix Totals

MATRIX	Cars 2012 Post ME PCU	LGV 2012 Post ME PCU	HGV 2012 Post ME PCU	GRAND TOTALS 2012 Post ME PCU
AM	5,924,391	168,912	90,452	6,183,756
PM	6,386,920	143,867	59,814	6,590,601

4.7.4 Table 4.5 shows the flow validation results for the AM model. The 2012 WeLHAM OOC model results were compared to 2012 counts where those were available and 2009 counts were they were not available.

4.7.5 The described network changes and matrix estimation have resulted in an improvement of the validation in the OOC study area. Compared to the 2009 WeLHAM OOC model, locations with GEH of 5 or less have increased from 67% to 86% and locations with a GEH of 7.5 or less have increased from 86% to 94%.

4.7.6 The validation on Victoria Road and Old Oak Common Lane has improved as well to the extent that the GEH is below 5 in both directions. However, there has been a substantial deterioration on 2 out of 49 links compared to the 2009 WeLHAM OOC model, one of which is located close to the study area (Harrow Road West of Scrubs Lane). Since the links in the core study area validate sufficiently well, it was concluded that the poor validation on the link close to the boundary of the study area does not materially impact the results of the validation for this study.

Table 4.5 2009 WeLHAM OOC – 2012 WeLHAM OOC AM Flow Validation Comparison (OOC Area)

A node	B node	Traffic flows in PCU: AM 08:00-09:00													
		Observed 2009	Observed 2012	2009 WeLHAM Base Model				2009 WeLHAM OOC Base Model				HS2 2012 WeLHAM OOC Base Model			
				Model	Diff. 2009	% Diff. 2009	GEH	Model	Diff. 2009	% Diff. 2009	GEH	Model	Diff. 2009/2012 Obs	% Diff. 2009/2012 Obs	GEH 2009/2012 Obs
64385	64386	2,990	3,068	2,272	-718	-24	14.00	2,568	-422	-14	8.01	2,932	-135	-4	2.47
64342	64341	2,379	2,645	2,451	72	3	1.47	2,307	-72	-3	1.49	2,463	-182	-7	3.60
64156	64359	924	-	356	-568	-61	22.45	980	56	6	1.81	899	-25	-3	0.81
64095	64156	1,054	-	1,078	24	2	0.74	829	-225	-21	7.33	1,062	8	1	0.24
64023	64211	1,697	-	1,767	70	4	1.68	1,886	189	11	4.47	1,826	129	8	3.08
64368	64383	2,034	-	1,437	-597	-29	14.33	2,071	37	2	0.82	2,023	-11	-1	0.24
64101	64624	342	361	252	-90	-26	5.22	458	116	34	5.80	354	-7	-2	0.37
64624	64101	463	495	716	253	55	10.42	627	164	35	7.02	465	-31	-6	1.41
66156	66155	3,680	-	3,379	-301	-8	5.07	3,697	17	0	0.28	3,455	-225	-6	3.77
66155	66156	3,545	-	3,032	-513	-14	8.95	3,573	28	1	0.47	3,502	-43	-1	0.73
66154	66077	3,181	-	3,691	510	16	8.70	3,574	393	12	6.76	3,421	240	8	4.18
66077	66154	3,220	-	2,827	-393	-12	7.15	3,217	-3	0	0.05	3,198	-22	-1	0.38
64124	64407	3,049	-	3,120	71	2	1.28	3,255	206	7	3.67	3,123	74	2	1.34
64407	64124	3,080	-	2,217	-863	-28	16.77	2,962	-118	-4	2.15	3,053	-27	-1	0.49
64099	64646	448	393	305	-143	-32	7.37	398	-50	-11	2.43	397	5	1	0.23
64646	64099	406	396	77	-329	-81	21.17	433	27	7	1.32	374	-22	-6	1.14
64100	65092	301	286	295	-6	-2	0.35	228	-73	-24	4.49	289	2	1	0.13
65092	64100	374	338	313	-61	-16	3.29	466	92	25	4.49	320	-18	-5	1.00
64157	64122	925	-	829	-96	-10	3.24	874	-51	-6	1.70	917	-8	-1	0.27
64122	64157	1,288	-	1,189	-99	-8	2.81	1,355	67	5	1.84	1,338	50	4	1.39
64133	64156	1,554	-	1,340	-214	-14	5.63	2,066	512	33	12.03	1,618	64	4	1.61
64156	64133	1,796	-	1,761	-35	-2	0.83	1,946	150	8	3.47	1,979	183	10	4.21
64123	66009	153	-	291	138	90	9.26	219	66	43	4.84	175	22	15	1.75
66009	64123	199	-	337	138	69	8.43	246	47	24	3.15	227	28	14	1.93
65101	64097	1,693	1,299	1,178	-515	-30	13.59	1,873	180	11	4.26	1,274	-25	-2	0.69
64093	64023	3,800	-	3,752	-48	-1	0.78	3,923	123	3	1.98	4,185	385	10	6.09
64021	64155	3,180	-	2,635	-545	-17	10.11	3,274	94	3	1.65	3,325	145	5	2.54
64125	64063	1,155	-	1,219	64	6	1.86	1,436	281	24	7.81	1,183	28	2	0.82
64063	64125	960	-	1,174	214	22	6.55	1,157	197	21	6.06	1,133	173	18	5.34
66435	66510	853	-	865	12	1	0.41	947	94	11	3.13	855	2	0	0.08
66510	66435	1,076	-	948	-128	-12	4.02	932	-144	-13	4.54	911	-165	-15	5.25
66388	66448	454	-	511	57	13	2.59	489	35	8	1.61	505	51	11	2.34
66448	66388	682	-	229	-453	-66	21.23	761	79	12	2.94	719	37	5	1.39
66148	66147	668	-	318	-350	-52	15.76	264	-404	-60	18.71	294	-374	-56	17.07
66147	66148	1,013	-	1,014	1	0	0.03	977	-36	-4	1.14	967	-46	-4	1.45
66137	66452	432	-	493	61	14	2.84	434	2	0	0.10	405	-27	-6	1.34
66452	66137	382	-	369	-13	-3	0.67	368	-14	-4	0.72	218	-164	-43	9.50
64235	66211	394	414	400	6	2	0.30	535	141	36	6.54	504	91	22	4.24
66211	64235	793	633	839	46	6	1.61	852	59	7	2.06	672	39	6	1.54
66205	66025	629	-	658	29	5	1.14	633	4	1	0.16	637	8	1	0.32
66025	66205	1,077	-	814	-263	-24	8.55	890	-187	-17	5.96	719	-358	-33	11.96
32167	32094	590	529	719	129	22	5.04	726	136	23	5.30	542	13	2	0.57
32094	32167	633	776	823	190	30	7.04	695	62	10	2.41	754	-22	-3	0.78
64998	64129	328	276	226	-102	-31	6.13	189	-139	-42	8.65	300	24	9	1.40
64129	64998	458	401	201	-257	-56	14.16	242	-216	-47	11.55	342	-59	-15	3.05
64067	64096	1,022	895	737	-285	-28	9.61	721	-301	-29	10.20	722	-172	-19	6.07
64096	64067	582	569	682	100	17	3.98	755	173	30	6.69	692	124	22	4.92
64089	64212	4,066	-	3,567	-499	-12	8.08	3,942	-124	-3	1.96	3,940	-126	-3	1.99
64212	64089	4,729	-	5,208	479	10	6.80	4,663	-66	-1	0.96	4,903	174	4	2.51
					GEH<5:		43%		GEH<5:		67%			GEH<5:	86%
					GEH<7.5:		63%		GEH<7.5:		86%			GEH<7.5:	94%

Table 4.6 2009 WeLHAM OOC – 2012 WeLHAM OOC PM Flow Validation Comparison (OOC Area)

Site description	A node	B node	Observed 2009	Observed 2012	WeLHAM Base Model	WeLHAM Base Diff. 2009	WeLHAM Base % Diff. 2009	WeLHAM Base GEH	OOC OAPF Base Model	OOC OAPF Base Diff. 2009	OOC OAPF Base % Diff. 2009	OOC OAPF Base GEH	HS2 C221 OOC Base Model	HS2 C221 OOC Base Diff. 2009/2012 Obs	HS2 C221 OOC Base % Diff. 2009/2012 Obs	HS2 C221 OOC Base GEH 2009/2012 Obs
			Traffic flows in PCU: PM 17:00-18:00													
A40 W of A4000 e/b	64385	64386	2,276	2,686	2,097	-179	-8	3.83	2,257	-19	-1	0.40	2,335	-351	-13	7.01
A40 E of A4000 w/b	64342	64341	3,319	3,661	3,248	-71	-2	1.24	3,491	172	5	2.95	3,461	-200	-5	3.36
A40 E of HLG e/b	64156	64359	596	-	36	-560	-94	31.50	407	-189	-32	8.44	618	22	4	0.90
A40 E of HLG w/b	64095	64156	1,138	-	981	-157	-14	4.82	1,059	-79	-7	2.38	1,045	-93	-8	2.83
A40 W of HLG e/b	64023	64211	1,768	-	1,524	-244	-14	6.01	1,889	121	7	2.83	1,775	7	0	0.18
A40 W of HLG w/b	64368	64383	2,001	-	1,628	-373	-19	8.76	2,117	116	6	2.56	2,139	138	7	3.04
A4000 Victoria Rd n/b	64101	64624	330	354	703	373	113	16.41	279	-51	-15	2.92	283	-72	-20	4.01
A4000 Victoria Rd s/b	64624	64101	491	534	607	116	24	4.95	688	197	40	8.11	481	-54	-10	2.39
A406 between Abbey Rd/A404 n/b	66156	66155	4,511	-	3,385	-1,126	-25	17.92	4,370	-141	-3	2.12	4,168	-343	-8	5.21
A406 between Abbey Rd/A404 s/b	66155	66156	3,408	-	3,197	-211	-6	3.67	3,193	-215	-6	3.74	3,505	97	3	1.65
A406 N of A404 Jnc. n/b	66154	66077	4,335	-	4,176	-159	-4	2.44	4,660	325	7	4.85	4,492	157	4	2.37
A406 N of A404 Jnc. s/b	66077	66154	3,273	-	3,332	59	2	1.03	3,186	-87	-3	1.53	3,369	96	3	1.67
A406 N of HLG n/b	64124	64407	3,297	-	2,856	-441	-13	7.95	3,477	180	5	3.09	3,411	114	3	1.97
A406 N of HLG s/b	64407	64124	2,735	-	2,735	0	0	0.00	2,513	-222	-8	4.33	3,075	340	12	6.30
B4492 Park Royal Rd n/b	64099	64646	563	351	316	-247	-44	11.78	444	-119	-21	5.30	353	2	1	0.11
B4492 Park Royal Rd s/b	64646	64099	326	519	316	-10	-3	0.56	574	248	76	11.69	430	-89	-17	4.10
Chase Rd n/b	64100	65092	223	211	336	113	51	6.76	126	-97	-43	7.34	197	-14	-7	0.99
Chase Rd s/b	65092	64100	440	423	312	-128	-29	6.60	431	-9	-2	0.43	253	-170	-40	9.27
Hanger Lane N of HLG n/b	64157	64122	980	-	964	-16	-2	0.51	1,043	63	6	1.98	1,062	82	8	2.55
Hanger Lane N of HLG s/b	64122	64157	1,222	-	1,064	-158	-13	4.67	1,437	215	18	5.90	1,236	14	1	0.39
Hanger Lane S of HLG n/b	64133	64156	1,327	-	1,205	-122	-9	3.43	1,618	291	22	7.58	1,624	297	22	7.74
Hanger Lane S of HLG s/b	64156	64133	1,477	-	1,850	373	25	9.15	1,586	109	7	2.79	1,645	168	11	4.25
Twyford Abbey Rd ne/b	64123	66009	97	-	70	-27	-28	2.95	143	46	47	4.20	129	32	33	3.05
Twyford Abbey Rd sw/b	66009	64123	246	-	260	14	6	0.88	305	59	24	3.55	286	40	16	2.44
Wales Farm Rd s/b	65101	64097	2,100	1,164	1,569	-531	-25	12.40	1,831	-269	-13	6.07	1,172	9	1	0.25
RSI Inner EB: A40 Western Av nr Alperton Ln	64093	64023	3,500	-	3,011	-489	-14	8.57	3,528	28	1	0.47	3,542	42	1	0.71
RSI Inner WB: A40 Western Av nr Alperton Ln	64021	64155	4,200	-	4,008	-192	-5	3.00	4,516	316	8	4.79	4,413	213	5	3.24
EW Inner NB: Hanger Ln S of Queens Dr	64125	64063	1,125	-	1,229	104	9	3.03	1,503	378	34	10.43	1,474	349	31	9.69
EW Inner SB: Hanger Ln S of Queens Dr	64063	64125	1,185	-	1,452	267	23	7.35	1,397	212	18	5.90	1,313	128	11	3.62
Wembley I/B Enc: Harrow Rd NW of A406 Jnc nw/b	66435	66510	1,039	-	1,104	65	6	1.99	1,108	69	7	2.11	1,024	-15	-1	0.47
Wembley O/B Enc: Harrow Rd NW of A406 Jnc se/b	66510	66435	916	-	1,005	89	10	2.87	924	8	1	0.26	977	61	7	1.97
Val EW2 NB: Abbey Rd N of Cumberland Av	66388	66448	911	-	741	-170	-19	5.92	761	-150	-16	5.19	950	39	4	1.29
Val EW2 SB: Abbey Rd N of Cumberland Av	66448	66388	496	-	508	12	2	0.54	572	76	15	3.29	594	98	20	4.19
NS Inner Central EB: A404 Craven Park W of A407 Jnc	66148	66147	458	-	374	-84	-18	4.12	364	-94	-21	4.64	376	-82	-18	4.02
NS Inner Central WB: A404 Craven Park W of A407 Jnc	66147	66148	900	-	945	45	5	1.48	915	15	2	0.50	894	-6	-1	0.21
NS Inner Central EB: Acton Ln N of Mordaunt Rd Jnc	66137	66452	503	-	569	66	13	2.85	601	98	19	4.17	549	46	9	2.01
NS Inner Central EB: Acton Ln N of Mordaunt Rd Jnc	66452	66137	434	-	433	-1	0	0.05	377	-57	-13	2.83	386	-48	-11	2.37
Val EW2 NB: A4000 Station Rd S of Tubbs Rd	64235	66211	712	578	703	-9	-1	0.34	714	2	0	0.07	696	118	20	4.68
Val EW2 SB: A4000 Station Rd S of Tubbs Rd	66211	64235	431	429	607	176	41	7.73	562	131	30	5.88	625	196	46	8.52
Val EW2 NB: A404 Harrow Rd W of Scrubs Ln	66205	66025	705	-	730	25	4	0.93	707	2	0	0.08	790	85	12	3.10
Val EW2 SB: A404 Harrow Rd W of Scrubs Ln	66025	66205	789	-	766	-23	-3	0.82	788	-1	0	0.04	590	-199	-25	7.58
EW Inner NB: Scrubs Ln at Mitre Bridge	32167	32094	938	909	1,066	128	14	4.04	1,104	166	18	5.20	967	58	6	1.89
EW Inner SB: Scrubs Ln at Mitre Bridge	32094	32167	606	601	739	133	22	5.13	716	110	18	4.28	588	-13	-2	0.53
EW Inner NB: Old Oak Common Ln S of A4000	64998	64129	604	469	432	-172	-28	7.56	450	-154	-25	6.71	377	-92	-20	4.49
EW Inner SB: Old Oak Common Ln S of A4000	64129	64998	247	273	133	-114	-46	8.27	182	-65	-26	4.44	281	8	3	0.50
EW Inner NB: A4000 Horn Ln S of Noel Rd	64067	64096	993	964	610	-383	-39	13.53	582	-411	-41	14.65	584	-379	-39	13.63
EW Inner SB: A4000 Horn Ln S of Noel Rd	64096	64067	632	580	395	-237	-38	10.46	409	-223	-35	9.77	371	-209	-36	9.57
NS Mid Outer WB:	64089	64212	5,254	-	4,913	341	-6	4.78	5,323	69	1	0.95	5,285	31	1	0.43
NS Mid Outer EB:	64212	64089	4,355	-	4,598	243	6	3.63	4,502	147	3	2.21	4,356	1	0	0.01
						GEH<5:		59%		GEH<5:		67%		GEH<5:		80%
						GEH<7.5:		71%		GEH<7.5:		86%		GEH<7.5:		86%

4.7.7 Table 4.6 shows the results of matrix estimation for the PM model. The 2012 WeLHAM OOC model results were compared to 2012 counts where those were available and 2009 counts were they were not available.

4.7.8 The described network changes and matrix estimation have resulted in a minor improvement of the validation in the OOC study area. Compared to the 2009 WeLHAM OOC model, locations with GEH of 5 or less have increased from 67% to 80%, whereas locations with a GEH of 7.5 have remained at 86%

4.7.9 The validation on Victoria Road and Old Oak Common Lane has improved to the extent that the GEH is below 5 in both directions. However, there has been a considerable deterioration on 4 out of 49 links compared to the 2009 WeLHAM OOC model, all of which are located close to the study area (A40, Chase Road, Station Road and Harrow Road west of Scrubs Lane). Although this deterioration is concerning and has to be addressed in future updates of the model, the main aim of improving the validation on Old Oak Common Lane and Victoria Road was achieved.

4.7.10 In general, the model does not validate well around the edges of the study area in the PM peak particularly links such as Acton Lane or Horn Lane. Despite the poor validation, the overall increase in locations with a GEH<5 shows an overall improved model.

4.7.11 Table 4.7 shows the level of validation of the AM model in the West Ruislip area. The number of locations with a GEH of less than 5 has increased from 50% to 93% and the number of locations with a GEH of less than 7.5 has increased from 57% to 100%. This represents a significant improvement compared to the previous version of the model.

Table 4.7 2009 WeLHAM OOC – 2012 WeLHAM OOC AM Flow Validation Comparison (West Ruislip Area)

Site description	A node	B node	Traffic flows in PCU: AM 08:00-09:00								
			Observed 2012	2009 WeLHAM OOC Base Model				HS2 C221 OOC Base			
				Model	Diff. 2012	% Diff. 2012	GEH	Model	Diff.2012 Obs	% Diff. 2012 Obs	GEH 2012 Obs
A412 North Orbital Road, Denham Green n/b	91890	91506	786	1,150	363	46	11.7	912	126	16	4.32
A412 North Orbital Road, Denham Green s/b	91506	91890	1,084	1,374	290	27	8.3	1,219	135	12	3.98
Western Avenue, filmed from the B467 RBT e/b	62233	62321	4,390	4,405	15	0	0.2	4,309	-82	-2	1.24
Western Avenue, filmed from the B467 RBT w/b	62321	62233	4,113	4,856	743	18	11.1	4,142	28	1	0.44
Harvil Road North n/b	62124	62132	451	588	137	30	6.0	451	0	0	0.01
Harvil Road North s/b	62132	62124	431	390	-41	-10	2.0	431	0	0	0.02
Harvil Road South n/b	62109	62124	319	366	46	14	2.5	344	24	8	1.34
Harvil Road South s/b	62124	62109	502	428	-74	-15	3.4	454	-48	-10	2.20
Breakspear Road North n/b	62156	62141	403	33	-371	-92	25.1	335	-68	-17	3.56
Breakspear Road North s/b	62141	62156	299	31	-269	-90	20.9	207	-93	-31	5.82
Breakspear Road South (Near Rail Bridge) n/b	62110	62123	517	591	74	14	3.2	542	25	5	1.10
Breakspear Road South (Near Rail Bridge) s/b	62123	62110	646	733	87	14	3.3	680	34	5	1.32
Ickenham Road (BTW West Ruislip Station and Ickenham Close) n/b	62447	62114	819	1,076	258	31	8.4	813	-5	-1	0.19
Ickenham Road (BTW West Ruislip Station and Ickenham Close) s/b	62114	62447	1,113	1,275	161	15	4.7	1,224	111	10	3.25
					GEH<5:		50%			GEH<5:	93%
					GEH<7.5:		57%			GEH<7.5:	100%

4.7.12 Table 4.8 shows the level of validation of the PM model in the West Ruislip area. The number of locations with a GEH of less than 5 has increased from 50% to 100% and the number of locations with a GEH of less than 7.5 has increased from 64% to 100%. This represents a significant improvement compared to the previous version of the model.

Table 4.8 2009 WeLHAM OOC – 2012 WeLHAM OOC PM Flow Validation Comparison (West Ruislip Area)

Site description	A node	B node	Traffic flows in PCU: PM 17:00-18:00									
			Observed 2012	2009 WeLHAM OOC Base Model				HS2 C221 OOC Base			
				Model	Diff. 2012	% Diff. 2012	GEH	Model	Diff.2012 Obs	% Diff. 2012 Obs	GEH 2012 Obs
A412 North Orbital Road, Denham Green n/b	91890	91506	916	953	38	4	1.2	951	35	4	1.13
A412 North Orbital Road, Denham Green s/b	91506	91890	979	1,143	164	17	5.0	953	-26	-3	0.83
Western Avenue, filmed from the B467 RBT e/b	62233	62321	4,565	4,620	54	1	0.8	4,599	34	1	0.50
Western Avenue, filmed from the B467 RBT w/b	62321	62233	4,660	4,075	-585	-13	8.9	4,585	-75	-2	1.10
Harvil Road North n/b	62124	62132	358	536	178	50	8.4	354	-4	-1	0.21
Harvil Road North s/b	62132	62124	453	428	-25	-5	1.2	430	-23	-5	1.09
Harvil Road South n/b	62109	62124	296	550	254	86	12.4	383	87	29	4.72
Harvil Road South s/b	62124	62109	413	356	-57	-14	2.9	446	33	8	1.59
Breakspear Road North n/b	62156	62141	223	18	-205	-92	18.7	169	-54	-24	3.83
Breakspear Road North s/b	62141	62156	316	37	-279	-88	21.0	320	4	1	0.22
Breakspear Road South (Near Rail Bridge) n/b	62110	62123	837	802	-36	-4	1.2	740	-97	-12	3.46
Breakspear Road South (Near Rail Bridge) s/b	62123	62110	497	541	44	9	1.9	485	-11	-2	0.52
Ickenham Road (BTW West Ruislip Station and Ickenham Close) n/b	62447	62114	1,109	1,312	203	18	5.8	1,109	0	0	0.00
Ickenham Road (BTW West Ruislip Station and Ickenham Close) s/b	62114	62447	959	1,097	138	14	4.3	963	4	0	0.12
					GEH<5:		50%			GEH<5:	100%
					GEH<7.5:		64%			GEH<7.5:	100%

4.7.13 Table 4.9 shows the AM screenline performance for TfL screenlines in the vicinity of both study areas. Appendix D shows the location of the screenlines. Table 4.9 illustrates that there are only minor differences between the 2009 WeLHAM OOC model and the 2012 WeLHAM OOC model.

4.7.14 Despite the fact that there is no material change in the screenline calibration, it is evident that the 'NS Inner Central' screenline calibration has decreased in both directions. This north-south screenline runs through the study area and includes the A40, Victoria Road and Acton Lane. It appears that the flow reduction on Acton Lane (westbound) has had a major effect on the calibration result.

Table 4.9 TfL Screenline Performance Comparison – WeLHAM AM Models

Study Area	Screenline	Direction	TfL 2009 Base		2009 WeLHAM OOC		2012 WeLHAM OOC	
			% Diff	GEH	% Diff	GEH	% Diff	GEH
OOC	EW Inner	Southbound	3	5	2	3	3	4
		Northbound	1	1	0	1	0	0
	NS Inner Central	Eastbound	-9	8	-8	7	-9	8
		Westbound	-3	2	-3	2	-7	6
	RSI Inner Scrl	Eastbound	2	3	5	7	5	7
		Westbound	4	6	8	11	8	10
	Hanger Lane/Willesden (EW2)	Southbound	-33	25	-24	18	-27	20
		Northbound	-9	5	-6	4	-3	2
West Ruislip	M25 Cordon	South-Eastbound	-1	1	0	0	-2	3
		North-Westbound	2	3	2	3	-2	4
	EW Outer	Northbound	-1	1	-1	2	-2	3
		Southbound	1	1	1	1	0	0
	NS Outer	Eastbound	-1	1	-2	3	-2	4
		Westbound	-2	4	-3	5	-4	7
	Northwood	Inbound	0	0	0	0	0	0
		Outbound	2	2	2	1	0	0

Source: URS WeLHAM Local Highway Model Calibration Report Rev03 (TfL 2009 Base and 2009 WeLHAM OOC) & C221 Analysis (2012 WeLHAM OOC)

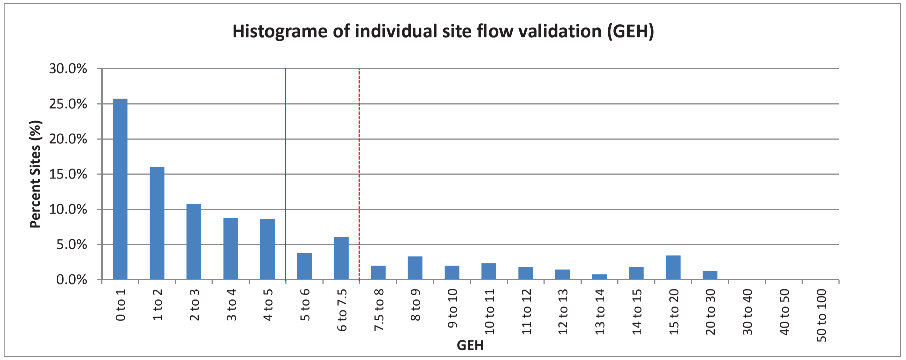
4.7.15 Table 4.10 and

Table 4.11 show extracts from the AM peak hour TfL dashboards which were set up to assess strategic performance of the model across a wide area using screenlines. These dashboards indicate that there has been no significant change in the calibration performance when the whole of WeLHAM is taken into account. The ‘Screenline with flow difference’ guidance has increased from 47 screenlines with a GEH of less than 5 to 48 screenlines with a GEH of less than 5. Appendix G shows the complete dashboard summary for the 2012 WeLHAM OOC model.

Table 4.10 AM 2009 WeLHAM OOC Dashboard Summary

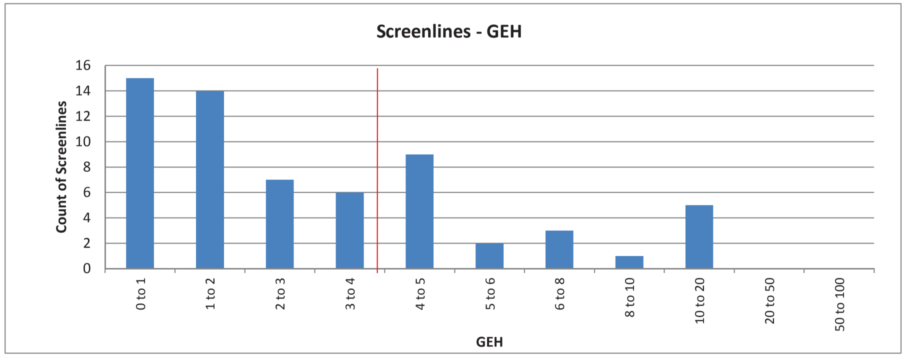
Counts Summary

	Total	%
No of counts	906	
criteria	635	70%
Counts with GEH <5	630	70%
Counts with GEH <7.5	719	79%



Screenline Summary

	Total	%
Total number of screenlines	62	
Total flow error across all screenlines		0%
Screenlines with flow difference <5%	47	76%
Screenlines with total flow error GEH<4	42	68%



Source: DashBoard_WeLHAM_BY09_OOCV11

Table 4.11 AM 2012 WeLHAM OOC Dashboard Summary

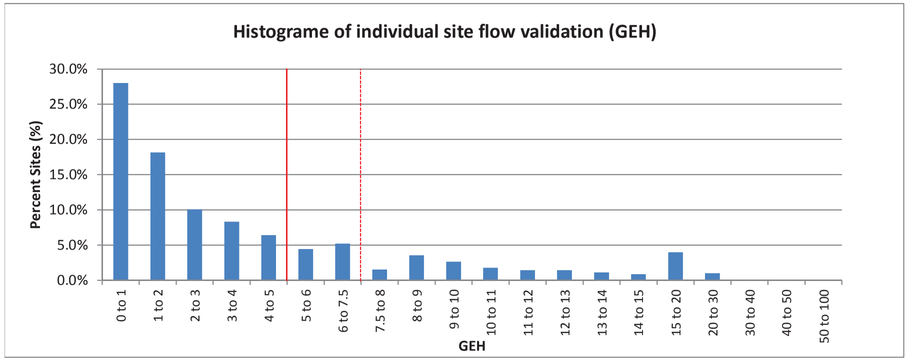
Date 10/07/2013

Model version 26

WeLHAM Performance Dashboard - AM peak

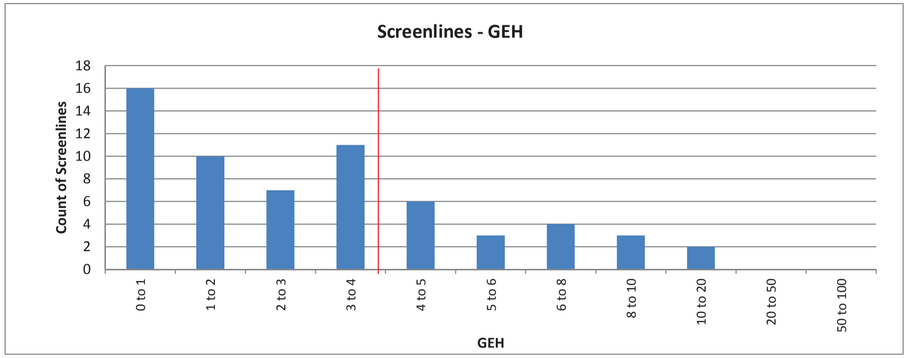
Counts Summary

	Total	%
No of counts	906	
criteria	649	72%
Counts with GEH <5	641	71%
Counts with GEH <7.5	728	80%



Screenline Summary

	Total	%
Total number of screenlines	62	
Total flow error across all screenlines		-1%
Screenlines with flow difference <5%	48	77%
Screenlines with total flow error GEH<4	44	71%



Source: DashBoard_WeLHAM_BY09_HS2_OOC_V4

4.7.16 The screenlines that have appeared to decline are shown in Table 4.12 While three screenlines have declined slightly, four screenlines have increased resulting in net increase from 47 to 48 screenlines with a GEH of less than 5.

Table 4.12 TfL Screenline Difference Comparison – WeLHAM AM Models

Screenline	Direction	TfL 2009 Base		2009 WeLHAM OOC		2012 WeLHAM OOC		
		% Diff	GEH	% Diff	GEH	% Diff	GEH	
NS Inner Central	Westbound	-3	2	-3	2	-7	6	Decrease in Calibration
Ealing	Outbound	-2	2	0	0	-6	5	
Feltham/Hounslow (NS4)	Eastbound	-5	2	-4	2	-8	3	
Notting Hill	Inbound	-5	2	-5	2	1	0	Increase in Calibration
RSI Inner Scrl	Eastbound	2	3	5	7	5	7	
River RSI Scrl Section 2	Southbound	-7	6	-6	5	-1	1	
Hanger Lane/Willesden (EW2)	Northbound	-9	5	-6	4	-3	2	

Source: TfL Dashboards

4.7.17 Table 4.13 shows the PM screenline comparison in the vicinity of both study areas. There are only minor differences between the 2009 WeLHAM OOC model and the 2012 WeLHAM OOC model. The number of screenlines with a flow difference of less than 5 has reduced as the Hanger Lane/Willesden screenline dropped from below 5 in both directions. However, the GEH comparison shows that two additional screenlines have a GEH that exceed 5 (M25 Cordon NWB, NS Outer WB).

Table 4.13 TfL Screenline Performance Comparison – WeLHAM PM Models

Study Area	Screenline	Direction	TfL 2009 Base		2009 WeLHAM OOC		2012 WeLHAM OOC	
			% Diff	GEH	% Diff	GEH	% Diff	GEH
OOC	EW Inner	Southbound	0	1	0	0	0	0
		Northbound	3	5	4	6	4	7
	NS Inner Central	Eastbound	-2	2	-3	2	-1	1
		Westbound	-1	1	-3	2	-6	5
	RSI Inner Scrl	Eastbound	4	5	8	11	10	13
		Westbound	4	6	7	10	6	8
	Hanger Lane/Willesden (EW2)	Southbound	-4	2	-6	3	-1	1
		Northbound	-7	5	-8	5	0	0
West Ruislip	M25 Cordon	South-Eastbound	3	4	2	4	1	1
		North-Westbound	3	5	3	5	4	6
	EW Outer	Northbound	2	3	3	4	1	2
		Southbound	1	1	1	1	0	0
	NS Outer	Eastbound	-1	1	-1	2	-2	3
		Westbound	-1	2	-2	3	-5	8
	Northwood	Inbound	3	2	3	2	1	1
		Outbound	1	1	1	1	1	1

Source: URS WeLHAM Local Highway Model Calibration Report Rev03 (TfL 2009 Base and 2009 WeLHAM OOC) & C221 Analysis (2012 WeLHAM OOC)

4.7.18 Table 4.14 and

Table 4.15 show the TfL Dashboard performance for the 2009 WeLHAM PM model and the 2012 WeLHAM PM model. A minor reduction in the screenline calibration performance can be observed as the number of screenlines with a flow percent difference of less than 5% drops from 46 to 43.

Table 4.14 PM 2009 WeLHAM OOC Dashboard Summary

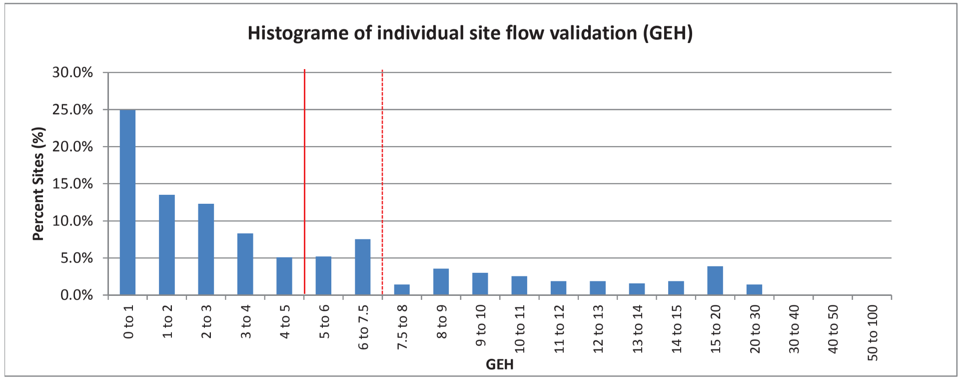
Date 27/07/2012

Model version 26

WeLHAM Performance Dashboard - PM peak

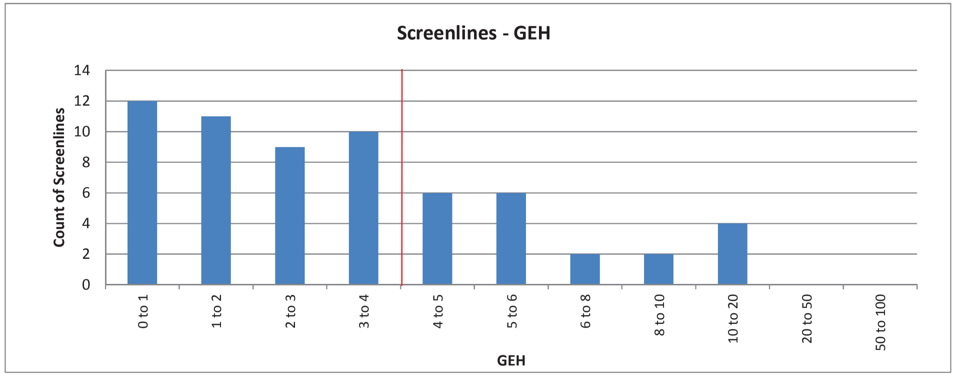
Counts Summary

	Total	%
No of counts	906	
criteria	611	67%
Counts with GEH <5	579	64%
Counts with GEH <7.5	694	77%



Screenline Summary

	Total	%
number	62	
flow		1%
nes with	45	73%
Screenlines with total flow error GEH<4	42	68%



DashBoard_WeLHAM_BY09_OOCV11

Table 4.15 PM 2012 WeLHAM OOC Dashboard Summary

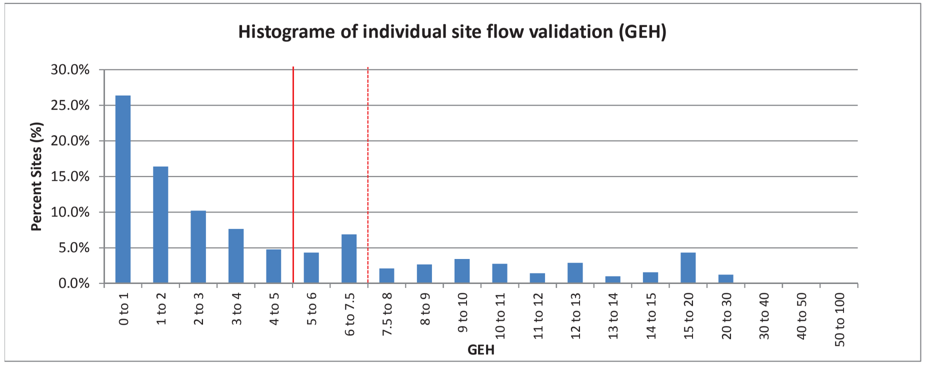
WeLHAM Performance Dashboard - PM peak

Date 10/07/2013

Model version 26

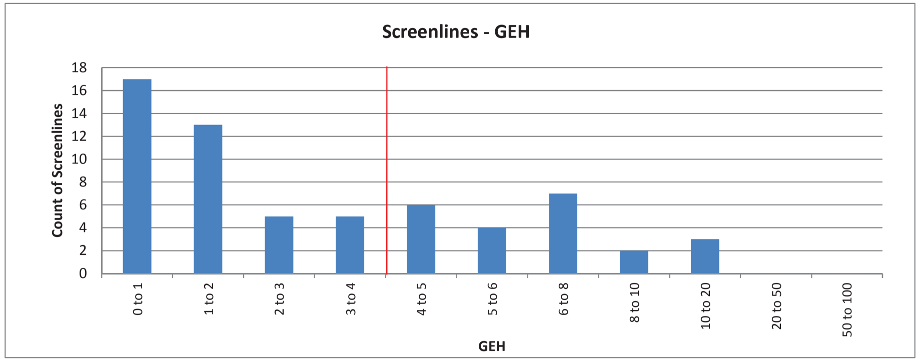
Counts Summary

	Total	%
No of counts	906	
criteria	619	68%
Counts with GEH <5	590	65%
Counts with GEH <7.5	691	76%



Screenline Summary

	Total	%
number	62	
flow		0%
nes with	43	69%
Screenlines with total flow error GEH<4	40	65%



Source: DashBoard_WeLHAM_BY09_HS2_OOC_V4

4.7.19 Table 4.16 shows the screenline calibration summary for all three WeLHAM models. The performance of 7 screenlines decreases while the performance of only 5 screenlines increases.

Table 4.16 TfL Screenline Difference Comparison – WeLHAM PM Models

Screenline	Direction	TfL 2009 Base		2009 WeLHAM OOC		2012 WeLHAM OOC		
		% Diff	GEH	% Diff	GEH	% Diff	GEH	
NS Inner Central	Westbound	-1	1	-3	2	-6	5	Decrease in Calibration
Harrow	Inbound	-4	4	-4	4	-6	6	
Harrow	Outbound	-5	5	-4	5	-5	5	
Ealing	Inbound	-2	1	-4	3	-9	8	
Notting Hill	Inbound	-2	1	-1	1	5	2	
River RSI Scrl Section 2	Northbound	0	0	1	1	6	5	
River RSI Scrl Section 2	Southbound	3	3	3	3	7	6	
Wembley	Inbound	-4	3	-5	4	-5	3	Increase in Calibration
Hanger Lane/Willesden (EW2)	Southbound	-4	2	-6	3	-1	1	
Hanger Lane/Willesden (EW2)	Northbound	-7	5	-8	5	0	0	
South of Heathrow (EW3)	Northbound	-8	5	-9	5	-5	3	
Ealing/Brentford (NS3)	Westbound	-7	3	-9	3	-3	1	

Source: TfL Dashboards

4.7.20 The calibration of journey times is based on TrafficMaster data provided by TfL. A number of datasets were provided and TfL recommended using monthly hourly data averages summarised by hours between 06:00-22:00. It was agreed to use November 2011 data for the calibration as it was the most recent neutral month that was provided.

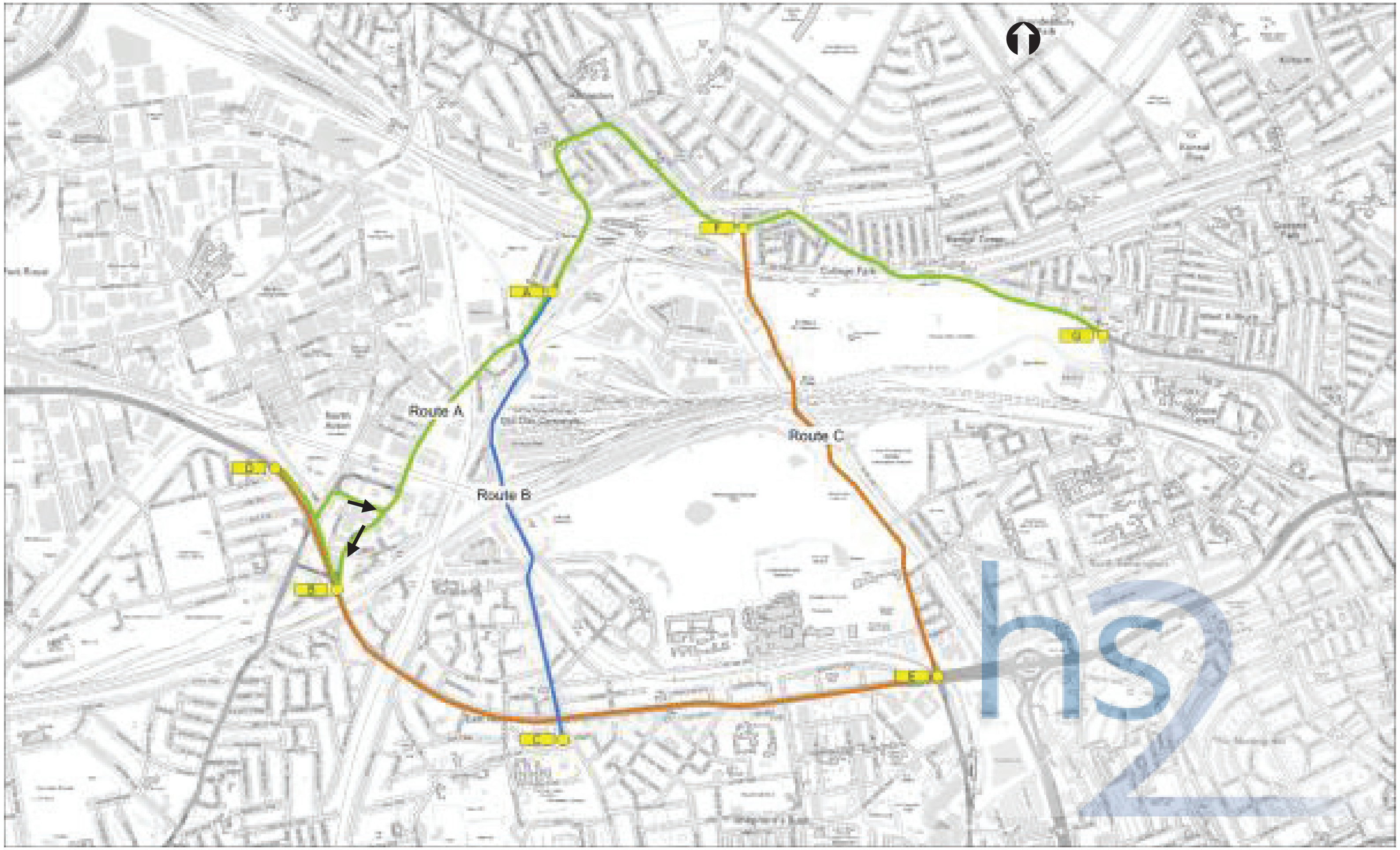
4.7.21 Three journey time routes were identified in the OOC and West Ruislip study areas. Figure 4.1 shows the journey time routes in the OOC area.

1. Route A runs along Harrow Road, Victoria Road and then joins the A40. This route aims to test the journey times on Victoria Road, the Gyratory and access to the A40.

2. Route B tests the journey time along Old Oak Common Lane and access to the A40 junction at Savoy Circus.

3. Route C tests the journey time along Scrubs Lane, the A40 junction with Scrubs Lane as well as the A40 past Gypsy Corner.

Figure 4.1 OOC Study Area Journey Time Routes



Source: Contains Ordnance Survey Maps, 2012

4.7.22 Table 4.17 shows the journey times for the OOC area in the AM peak. All modelled cumulative journey times are within the TfL guidance of +/-15% of the observed times except from Route A northbound. It appears that there is significant observed delay which is not fully replicated in the model.

4.7.23 When examining the individual links along this route, it appears that the observed delay on the A404 Harrow Road at the junction with B450/Ladbroke Grove is not replicated in the model and is one of the main contributors to this difference. The observed journey time was 222 seconds whereas the modeling journey time was 53 seconds in the model. The detailed segmented comparison can be found in Appendix H.

Table 4.17 AM OOC Study Area Journey Time Performance

Journey Time Route	Observed (sec)	HS2 WeLHAM OOC (sec)	% Diff
Route A - Southbound	987	871	-12%
Route A - Northbound	1674	967	-42%
Route B - Southbound	424	417	-2%
Route B - Northbound	345	369	7%
Route C - Southbound	835	814	-2%
Route C - Northbound	828	744	-10%

Note: Observed information derived from data provided by TrafficMaster obtained from vehicles fitted with GPS devices. Produced by TfL Network Performance – Traffic Analysis Centre

4.7.24 Table 4.18 shows the journey times for the OOC area in the PM peak. Route A northbound falls short of the TfL guidance of +/-15% within the observed time by between 4 to 10%. For the southbound route this is mainly due to delays occurring at the north end of the A404/Harrow Road which are not sufficiently replicated in the model. Similarly, for the northbound direction, delays occurring at the north end of Old Oak Lane and the A404 are not replicated in the model.

4.7.25 Route B results in the worst journey time validation as the modelled times are substantially lower than the observed times. On the southbound route, the largest proportion of observed delay occurred on the junction with the A40. TrafficMaster data indicates that the journey time between Old Oak Common Lane/The Fairway Junction and Old Oak Road/East Acton Lane Junction (ca. 600m) is just below 9 minutes. The model is predicting a journey time of just over 3 minutes. In the opposite direction, the major delay occurs on the Old Oak Common Lane/Victoria Road Junction and traffic is delayed by around 5 minutes, whereas the model predicts a delay of just over 2.5 minutes.

4.7.26 The journey times of Route C southbound meets the TfL guidance, whereas northbound falls short of the guidance due to faster than observed journey times along the A40 between Savoy Circus Junction and the Scrubs Lane/A40 Junction (100 seconds faster in the model).

Table 4.18 PM OOC Study Area Journey Time Performance

Journey Time Route	Observed (sec)	HS2 WeLHAM OOC (sec)	% Diff
Route A - Southbound	1108	900	-19%
Route A - Northbound	1309	986	-25%
Route B - Southbound	718	370	-48%
Route B - Northbound	601	389	-35%
Route C - Southbound	1236	1071	-13%
Route C - Northbound	747	613	-18%

Note: Observed information derived from data provided by TrafficMaster obtained from vehicles fitted with GPS devices. Produced by TfL Network Performance – Traffic Analysis Centre

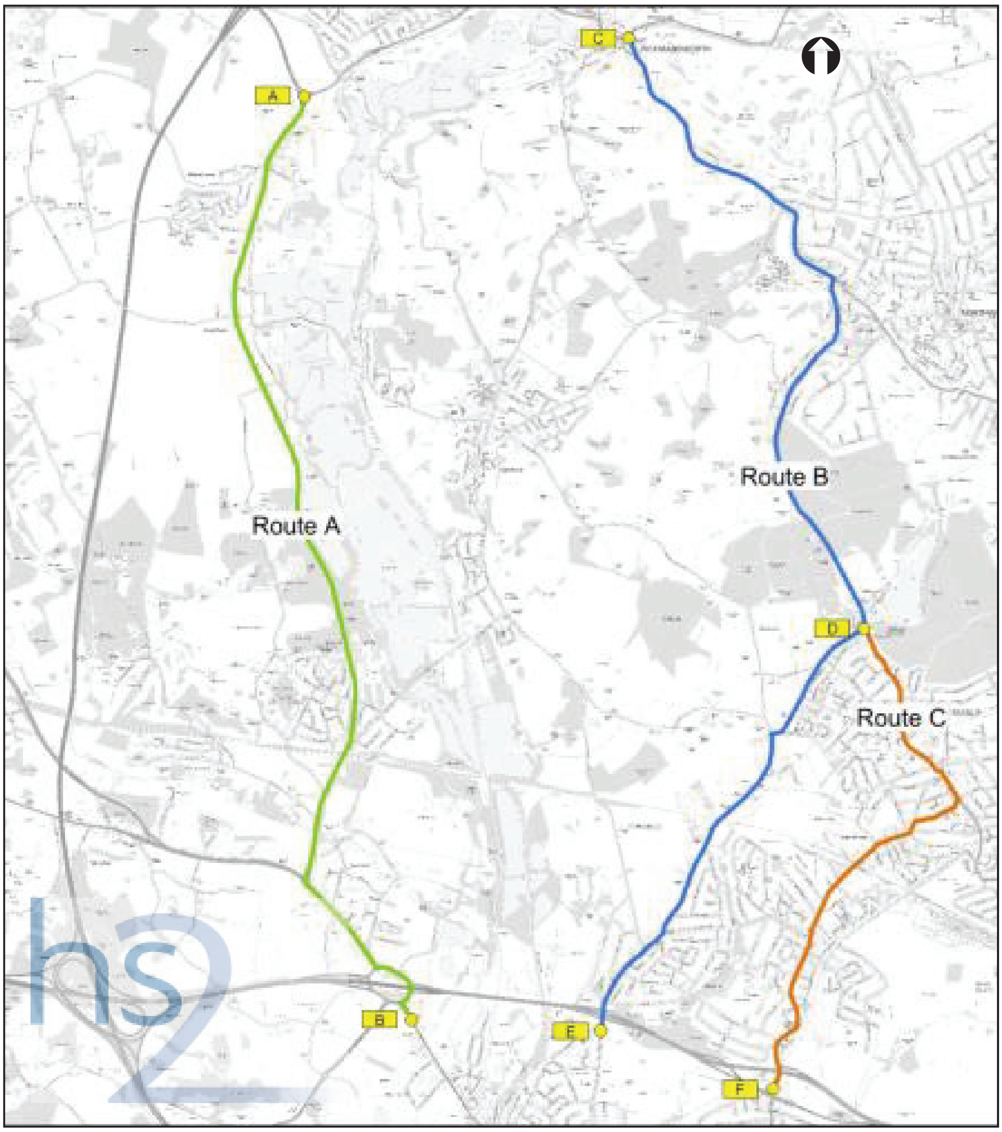
4.7.27 Figure 4.2 shows the journey time routes for the West Ruislip area. Due to limited TrafficMaster data being available for this area, it was not possible to include Harvil Road and Breakspear Road North.

1. Route A runs along A412/North Orbital Road, Denham Avenue and Oxford Road up to Denham Roundabout. It is expected that this route may be used as a diversion route during the time of construction in the West Ruislip area.

2. Route B runs parallel to Route A along the A404/London Road, A4180/Duck's Hill Road, Breakspear Road and Breakspear Road South as well as B467/Swakeleys Road up to the A40. It is expected that this route may be impacted by construction traffic.

3. Route C is a shorter route that runs along Bury Street, B466 Ickenham Road and Long Lane up to the A40. Ickenham High Road may experience some heavy construction traffic and Long Lane may be used as a diversion route to access the A40.

Figure 4.2 West Ruislip Journey Time Routes



Source: Contains Ordnance Survey Maps, 2012

4.7.28 Table 4.19 shows the journey time comparison for the West Ruislip study area in the AM peak. It appears that all southbound routes falls short of the TfL guidance of +/-15% within the observed time, whereas all the northbound routes meets the guidance. During the AM peak, there appears to be significant congestion on the main access routes to the A40 in this area, whereas flows coming from the A40 appear do not experience significant delays.

4.7.29 Observed data for Route A suggests that significant delays are occurring along this route that are not replicated in the model. The main bottleneck appears to be the signalised junction on North Orbital Road/Moorfield Road which experiences delays of up to 10 minutes according to TrafficMaster, whereas the model predicts a delay of 1.5 minutes.

4.7.30 The main cause of delay on Route B southbound which is resulting in the significant difference between observed and model journey times appears to

occur on the roundabout of Breakspear Road South and Swakeleys Road. The journey time to the roundabout approach according to TrafficMaster is 6.5 minutes compared to 3min journey time in the model.

4.7.31 The Route C southbound journey time difference is largely due to extensive journey times along B466/Ickenham Road. TrafficMaster is showing a total journey time from the High Street/Ickenham Road Junction to the Swakeleys Road/Ickenham Road Junction of 10 minutes, where as the model is predicting a journey time of 3.5 minutes.

Table 4.19 AM West Ruislip Study Area Journey Time Performance

Journey Time Route	Observed (sec)	HS2 WeLHAM OOC (sec)	% Diff
Route A - Southbound	1463	908	-38%
Route A - Northbound	853	933	9%
Route B - Southbound	1560	1196	-23%
Route B - Northbound	1012	1095	8%
Route C - Southbound	1173	737	-37%
Route C - Northbound	721	707	-2%

Note: Observed information derived from data provided by TrafficMaster obtained from vehicles fitted with GPS devices. Produced by TfL Network Performance – Traffic Analysis Centre

4.7.32 Table 4.20 shows that the PM journey times in general validate better against the observed journey times compared to the AM peak. Route B northbound very narrowly misses the TfL guidance of +/-15% of journey time difference within the observed journey time.

4.7.33 The modelled Route C northbound journey time is substantially different from the observed journey time. This is mainly due to delays occurring on Long Lane around the Swakeleys Road Junction. TrafficMaster is showing a journey time of 6.5 minutes for these links, whereas the model is projecting a journey time of 3.5 minutes.

Table 4.20 PM West Ruislip Study Area Journey Time Performance

Journey Time Route	Observed (sec)	HS2 WeLHAM OOC (sec)	% Diff
Route A - Southbound	890	987	11%
Route A - Northbound	880	997	13%
Route B - Southbound	1008	993	-1%
Route B - Northbound	1057	1219	15%
Route C - Southbound	639	683	7%
Route C - Northbound	872	541	-38%

Note: Observed information derived from data provided by TrafficMaster obtained from vehicles fitted with GPS devices. Produced by TfL Network Performance – Traffic Analysis Centre

4.7.34 The journey time performance tables suggest that the model validates where delays are minimal, however, in the peak journey time directions the model currently does not sufficiently replicate major delays at key junctions.

5 Forecast Model Performance

5.1.1 The 2012 WeLHAM OOC base model was used to derive the following forecast models:

- 2021 Reference Case
- 2021 Construction Tests
- 2026 Reference Case
- 2026 Operational Tests
- 2041 Reference Case
- 2041 Operational Tests

5.1.2 The forecast matrices for all forecast models are derived from the LTS model and were provided by TfL. As this model takes into account demographic changes and economic growth in different areas of London the increase in overall peak hour vehicular trips over the period from 2021 to 2041 is under 2.5% as Table 5.1 illustrates.

Table 5.1 Forecast Model Matrix Totals (PCUs/hour)

MATRIX Totals	GRAND TOTALS 2012 Post ME	2021 Reference Case	2026 Reference Case	2041 Reference Case
AM	6,183,756	6,230,901	6,260,882	6,307,117
AM % Change to 2012	-	0.8%	1.2%	2.0%
PM	6,590,601	6,648,413	6,683,314	6,739,150
PM % Change to 2012	-	0.9%	1.4%	2.3%

5.1.3 It is noted that peak hour growth in trips on the strategic road network is typically higher than on connecting local roads.

5.1.4 The convergence statistics for all Reference Case models were checked and they meet the Delta and %GAP guidance as set out by WebTag and therefore present a reasonably robust set of Transport Assessment models.

5.1.5 The 2021 construction test models were used to assess the impact of construction traffic on major junctions and road links in the OOC and West Ruislip areas. The 2026 and 2041 models were used to assess the impact of traffic generated at OOC Station.

6 Report Summary

6.1.1 This 2012 WeLHAM OOC Model Performance Report discusses the network modifications and local recalibration of two core study areas using the 2009 WeLHAM OOC model as the base. The aim was to provide a solid baseline for assessing the construction and operational impacts of HS2 around Old Oak Common and West Ruislip.

6.1.2 While the TfL 2009 WeLHAM OOC model already included a number of network changes, further changes were made in the OOC and West Ruislip study areas by HS2 to better reflect the actual network and potential traffic diversion routes.

6.1.3 A review of the model flows in the 2009 WeLHAM OOC model and comparison to 2012 count data showed that certain links in both study areas were not adequately represented. So as to improve the validation on these links, Matrix Estimation was run for the AM and PM peak models using 2012 survey and other data.

6.1.4 The results of Matrix Estimation showed a general improvement in flow validation on the majority of links in the study areas. The validation around West Ruislip in particular improved substantially. The TfL Dashboard suggests that the Matrix Estimation process did not materially affect the screenline calibration results for the AM model over the wider area. Matrix Estimation appears to have resulted in a minor decline of screenline calibration in the PM model.

6.1.5 A total of six journey time routes were identified in the two study areas. Journey Times in the AM model validate reasonably well in the OOC area but only half of the journey times meet the TfL guidance in the West Ruislip area. In the PM peak model, journey time modelling does fall short of the TfL guidance in the OOC area. This is due to delays at certain junction not being replicated adequately in the model. Journey times in the West Ruislip area validate reasonably well in the PM peak, although there is an general ‘underplaying’ of congestion in the AM peak, especially on routes heading towards the A40.

6.1.6 The main limitations of the model are poor flow validation around the edges of the OOC study area and insufficient delays at key junctions which affect the journey time validation in the peak direction. However, it is believed that this model still represents a substantial improvement over the 2009 WeLHAM OOC model and provides a better and more appropriate basis for assessing the strategic traffic effects of HS2 as well as identifying potential incremental changes arising from the construction and operational effects of HS2.

6.1.7 The forecast baseline 2021 model information developed from the TfL LTS matrices will be used as the benchmark for assessment of construction effects and the forecast 2026 and 2041 models for HS2 operational schemes.

6.1.8 For operational junction testing using TRANSYT it is noted that the absolute changes from HS2 will be manually loaded onto the forecast baseline HS2 TRANSYT model flows derived from the future WeLHAM models. This will provide a robust assessment, as no reduction is made for potential reassignment of traffic away from the area. Furthermore, it is anticipated that no reduction will be made for diverted trips to the new OOC station that may be already on the road network.

6.1.9 More detailed scheme refinement and testing of specific construction and operational sub-phases to assist in optimising the implementation of schemes may be appropriate post Hybrid Bill submission.

Appendix A – 2012 WeLHAM OOC Model Factsheet

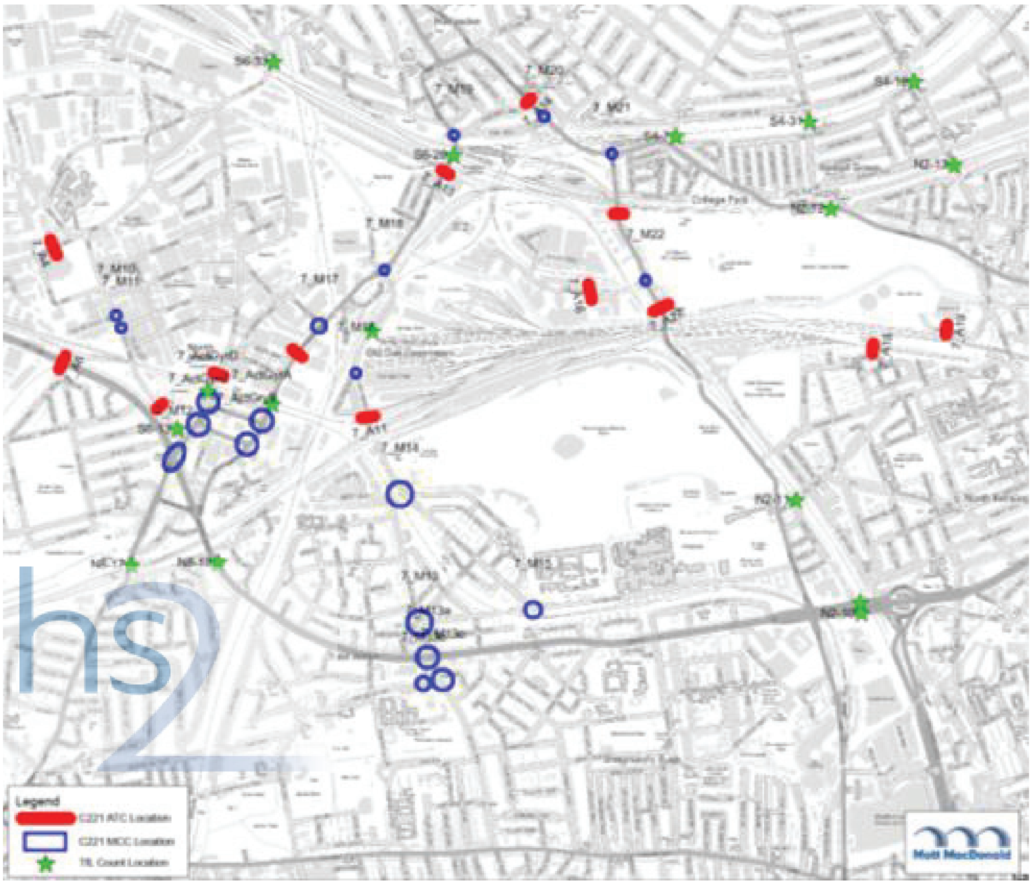
Core Study Area Boundaries	Old Oak Common	A40 (S) A404 Harrow Road (N) A219 Scrubs Lane (E) Park Royal Rd/Acton Lane (W)
	West Ruislip/Ickenham	A40 (S) Breakspear Rd North/Park Lane (N) Long Lane/High Road Ickenham (E) North Orbital Rd/Denham Av (W)
Counts	C221	Summer 2012
	TfL	Autumn 2012
SATURN Version	10.9.24 Large	
SATURN Zones	1816	
User Classes	UC1, UC2, UC3, UC4, UC5	
Base Year	AM	PM
Time Periods	08:00-09:00	17:00-18:00
PassQ Factor	0.88 (GONZO)	0.88 (GONZO)
PassQ Network	W1_B09_02b_A_MML_HS2_OOC_NE1_bq.dat	W1_B09_02b_P_MML_HS2_OOC_NE1_bq.dat
PassQ Matrix	W1_B09_AM_HS2_OOC.ufm	W1_B09_PM_HS2_OOC.ufm
PassQ Assigned Model	W1_B09_02b_A_MML_HS2_OOC_NE1_bq.ufs	W1_B09_02b_P_MML_HS2_OOC_NE1_bq.ufs
Peak Hour Network	W1_B09_02b_A_MML_HS2_OOC_NE1_b.dat	W1_B09_02b_P_MML_HS2_OOC_NE1_b.dat
Peak Hour Matrix	W1_B09_AM_HS2_OOC.ufm	W1_B09_PM_HS2_OOC.ufm
Peak Hour Assigned Model	W1_B09_02b_A_MML_HS2_OOC_NE1_b.ufs	W1_B09_02b_P_MML_HS2_OOC_NE1_b.ufs
KNOBS File	WL_CCS_KNOBS.dat	WL_CCS_KNOBS.dat

Appendix B - Matrix Estimation Counts Sites

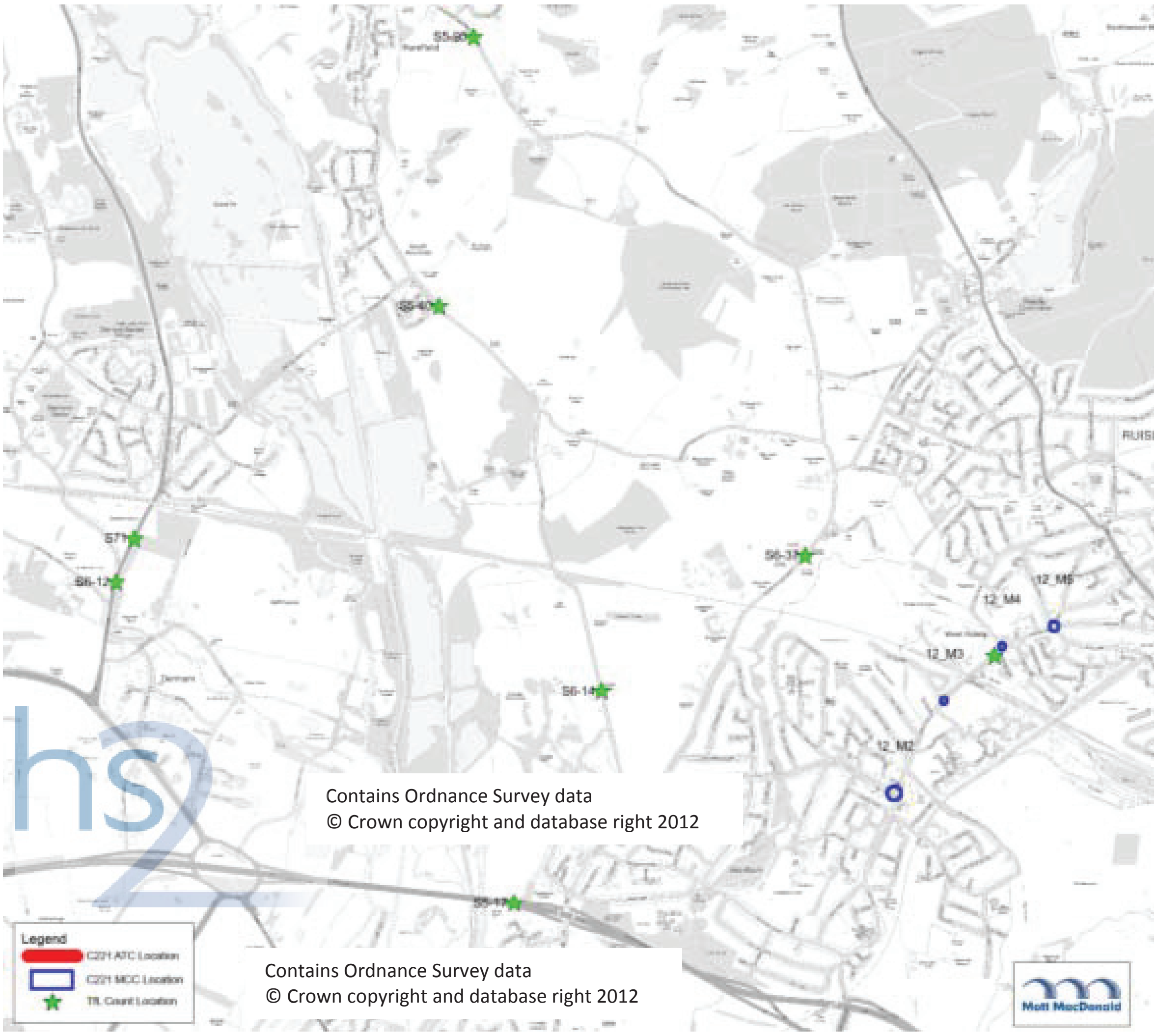
Area	Count ID	Count Type	Junction/Link Name	Direction
OOC	7_M19	MCC	Old Oak Lane / Station Road / Tubbs Road	SB
OOC	7_M19	MCC	Old Oak Lane / Station Road / Tubbs Road	NB
OOC	7_M19	MCC	Old Oak Lane / Station Road / Tubbs Road	NB
OOC	7_M19	MCC	Old Oak Lane / Station Road / Tubbs Road	EB
OOC	S4-6	ATC	Old Oak Common Lane	Northbound
OOC	S4-6	ATC	Old Oak Common Lane	Southbound
OOC	7_A11	ATC	Old Oak Common Lane	Northbound
OOC	7_A11	ATC	Old Oak Common Lane	Southbound
OOC	7_M15	MCC	Du Cane Rd / Wulfstan St	NB
OOC	7_M15	MCC	Du Cane Rd / Wulfstan St	WB
OOC	7_M15	MCC	Du Cane Rd / Wulfstan St	NB
OOC	7_M15	MCC	Du Cane Rd / Wulfstan St	EB
OOC	7_M15	MCC	Du Cane Rd / Wulfstan St	WB
OOC	7_M15	MCC	Du Cane Rd / Wulfstan St	EB
OOC	7_A4	ATC	Coronation Road	Northbound
OOC	7_A4	ATC	Coronation Road	Southbound
OOC	N8-18MCC	MCC	A40 Western Ave,South of Friary Rd	Northbound
OOC	N8-18MCC	MCC	A40 Western Ave,South of Friary Rd	Southbound
OOC	N8-17MCC	MCC	A4000 Horn Ln, at Acton Stn railway bridge	Northbound
OOC	N8-17MCC	MCC	A4000 Horn Ln, at Acton Stn railway bridge	Southbound
OOC	S6-18	ATC	Victoria Road	Northbound
OOC	S6-18	ATC	Victoria Road	Southbound
OOC	7_ActGyrB	MCC	Wales Farm Road/Victoria Road	SB
OOC	S6-49	ATC	Chase Road (Rail bridge)	Northbound
OOC	S6-49	ATC	Chase Road (Rail bridge)	Southbound
OOC	7_A8	ATC	Park Royal Road	Northbound
OOC	7_A8	ATC	Park Royal Road	Southbound
OOC	7_A27	ATC	Scrubs Lane	Northbound
OOC	7_A27	ATC	Scrubs Lane	Southbound
OOC	7_A16	ATC	Hythe Road	Northbound
OOC	7_A16	ATC	Hythe Road	Southbound
OOC	7_A15	ATC	Scrubs Lane	Northbound
OOC	7_A15	ATC	Scrubs Lane	Southbound
OOC	7_A14	ATC	High Street	Northbound
OOC	7_A14	ATC	High Street	Southbound
OOC	S6-33	ATC	Acton Lane (on Rail Bridge)	Northbound
OOC	S6-33	ATC	Acton Lane (on Rail Bridge)	Southbound
OOC	7_A6	LinkCount	A40 Western Road, between Mansfield Road and Kathleen Avenue	EB
OOC	7_A6	LinkCount	A40 Western Road, between Mansfield Road and Kathleen Avenue	WB
West Ruislip	S5-17	MCC	Western Avenue, filmed from the B467 RBT	Eastbound
West Ruislip	S5-17	MCC	Western Avenue, filmed from the B467 RBT	Westbound
West Ruislip	S5-40	ATC	Harvil Road	Northbound
West Ruislip	S5-40	ATC	Harvil Road	Southbound
West Ruislip	S6-14	ATC	Harvil Road	Northbound
West Ruislip	S6-14	ATC	Harvil Road	Southbound
West Ruislip	S5-95	ATC	Breakspear Road North	Northbound
West Ruislip	S5-95	ATC	Breakspear Road North	Southbound
West Ruislip	S6-37	ATC	Breakspear Road South (Near Rail Bridge, North of Copthall Road West)	Northbound
West Ruislip	S6-37	ATC	Breakspear Road South (Near Rail Bridge, North of Copthall Road West)	Southbound
West Ruislip	S6-31	ATC	Ickenham Road (BTW West Ruislip Station and Ickenham Close)	Northbound
West Ruislip	S6-31	ATC	Ickenham Road (BTW West Ruislip Station and Ickenham Close)	Southbound
West Ruislip	S6-12	ATC	Denham Avenue (north of Old Rectory Lane)	Northbound
West Ruislip	S6-12	ATC	Denham Avenue (north of Old Rectory Lane)	Southbound

Appendix C – Traffic Survey Locations

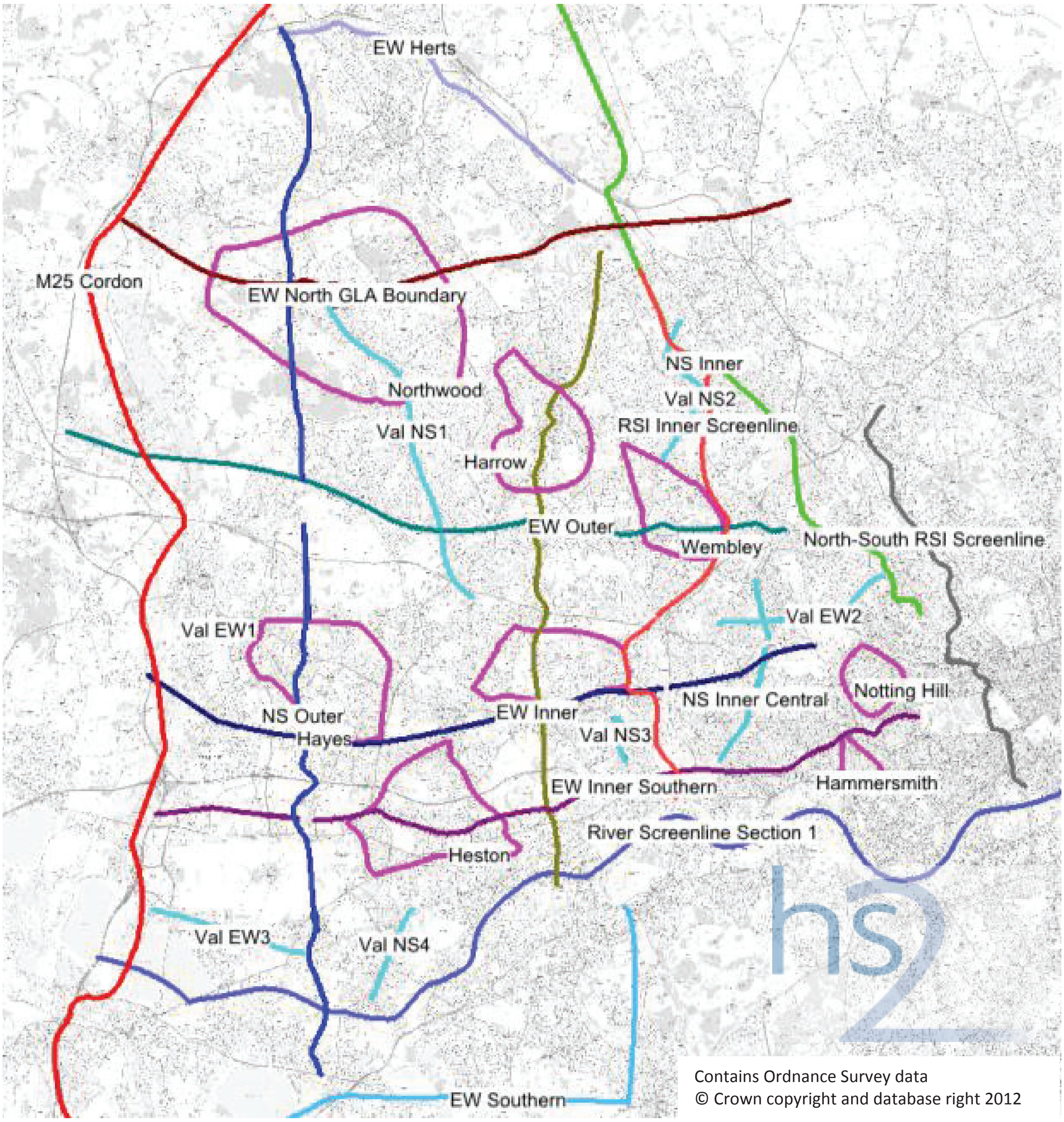
Traffic Count Survey Locations – Old Oak Common Area



Traffic Count Survey Locations – West Ruislip Area



Appendix D – WeLHAM Screenlines

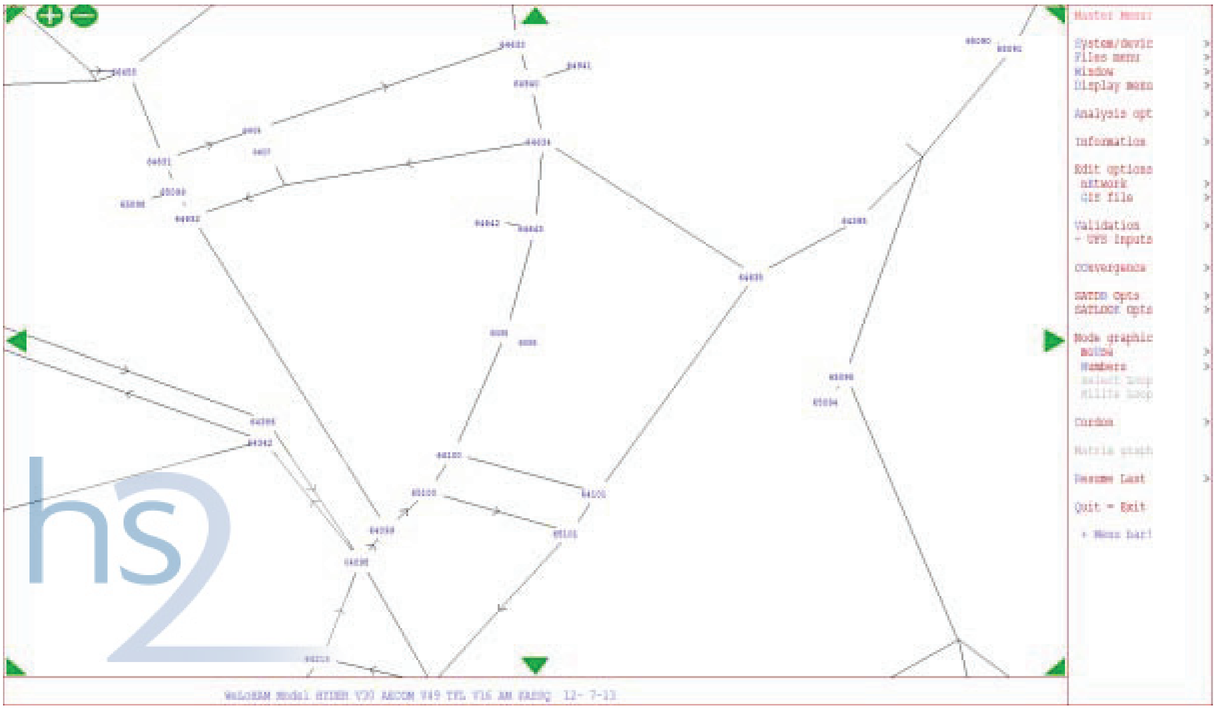


Source: Contains Ordnance survey data 2012; WeLHAM Screenline Layer provided by TfL

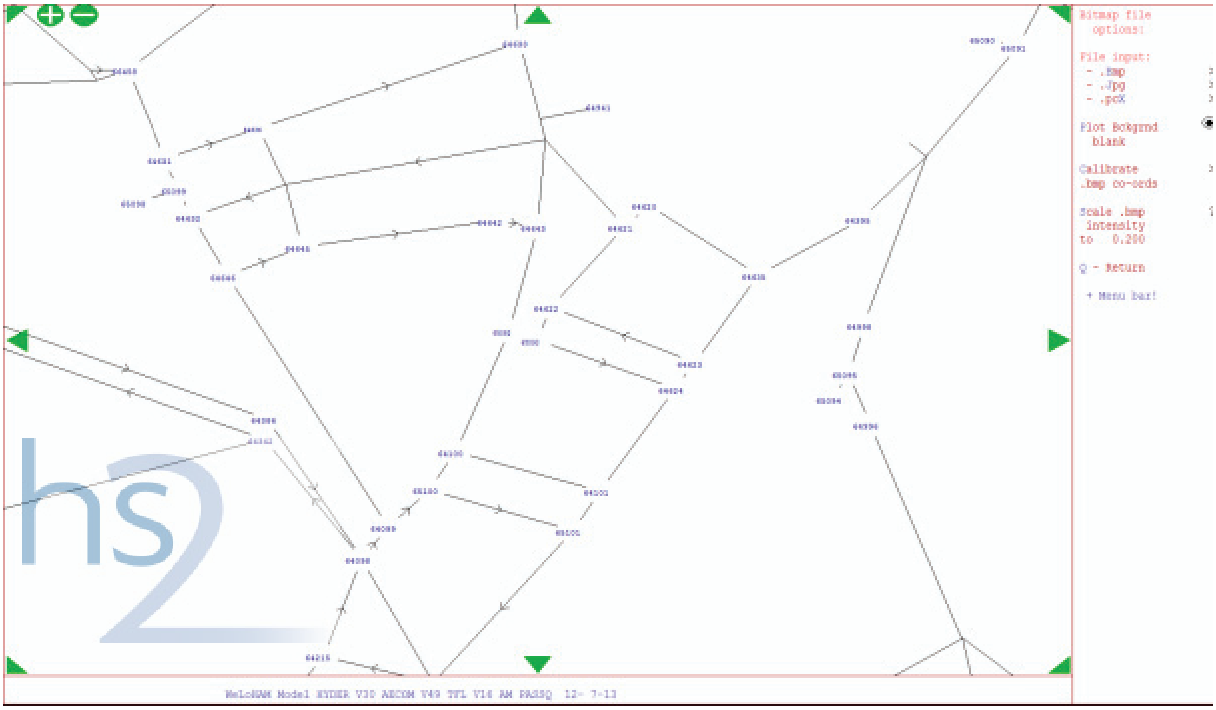
Appendix E – Network Adjustments

Added new links for Gorst Road, Bethune Road, School Road and St Leonard's Road

2009 WeLHAM OOC



2012 WeLHAM OOC



Appendix F – Matrix Comparison by User Class

	MATRIX	GRAND TOTALS Prior Matrix	GRAND TOTALS HS2 WeLHAM OOC	Difference Totals 2012 v Prior Matrix
AM Period	UC1 – Car Other	5,568,321	5,564,318	**-4,004**
	UC2 – Car Employee	333,830	331,203	**-2,627**
	UC3 – LGV	173,963	168,912	**-5,050**
	UC4 – HGV	91,202	90,452	**-750**
	UC5 - Taxi	28,875	28,871	**-4**
PM Period	UC1 – Car Other	5,902,970	5,911,530	**8,560**
	UC2 – Car Employee	431,993	430,665	**-1,328**
	UC3 – LGV	145,769	143,867	**-1,902**
	UC4 – HGV	63,113	59,814	**-3,299**
	UC5 - Taxi	44,743	44,725	**-18**

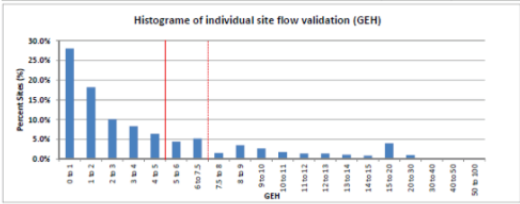
Appendix G – TfL Dashboards 2012 WeLHAM OOC

WeLHAM Performance Dashboard - AM peak

Date 10/07/2013
Model version 26

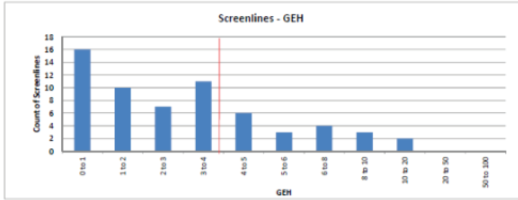
Counts Summary

	Total	%
No of counts	906	
criteria	649	72%
Counts with GEH <5	641	71%
Counts with GEH <7.5	728	80%



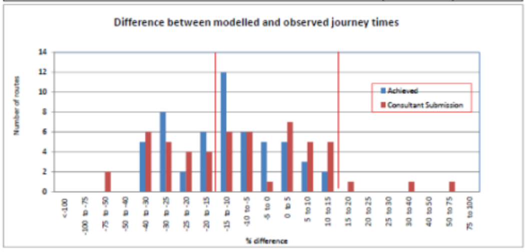
Screenline Summary

	Total	%
Total number of screenlines	62	
Total flow error across all screenlines		-1%
Screenlines with flow difference <5%	48	77%
Screenlines with total flow error GEH<4	44	71%

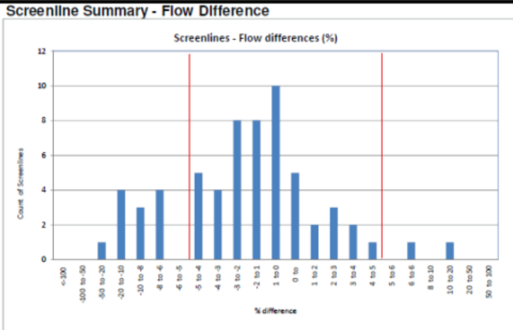


Journey Time Summary

	Total	%
Number of Routes	54	
(Modelled - Observed in	-12398	-15%
difference<15% or 1 min if	33	61%

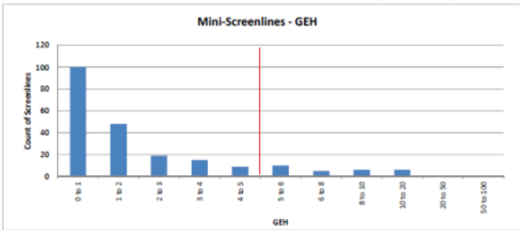


Screenline Summary - Flow Difference



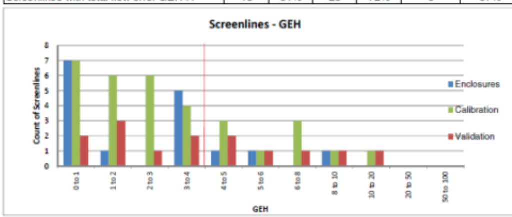
Mini Screenline Summary

	Total	%
screenlines	218	
mini screenlines		-1%
difference <5%	152	70%
Mini screenlines with total flow error GEH<4	191	88%

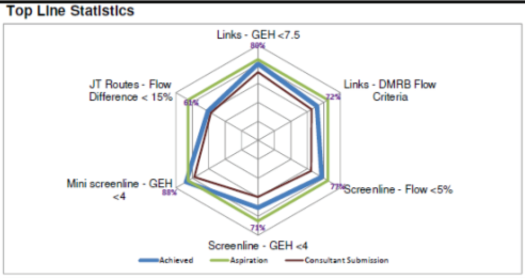


Screenline Summary by Type

	Enclosures Total	%	Calibration Total	%	Validation Total	%
Total number of screenlines	16		32		14	
Total flow error across all screenlines		-2%		0%		-7%
Screenlines with flow difference <5%	13	81%	28	88%	7	50%
Screenlines with total flow error GEH<4	13	81%	23	72%	8	57%

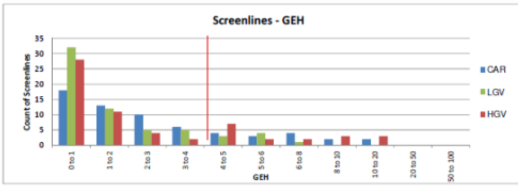


Top Line Statistics



Screenline Summary by Vehicle type

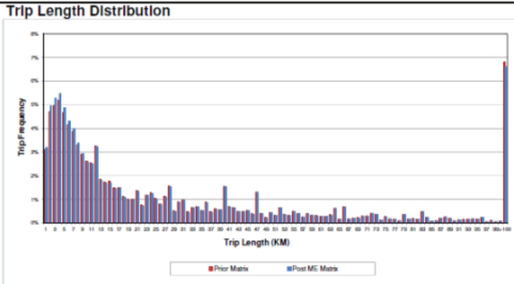
	Flow < 5%	GEH < 4
Car	74%	76%
LGV	58%	87%
HGV	45%	73%



Top Line Statistics

	Achieved	Aspiration	Consultant Submission
Links - GEH <7.5	80%	85%	72%
Links - DMRB Flow Criteria	72%	85%	65%
Screenline - Flow <5%	77%	85%	65%
Screenline - GEH <4	71%	85%	60%
Mini screenline - GEH <5	88%	85%	78%
JT Routes - Flow Difference < 15%	61%	85%	57%

Trip Length Distribution



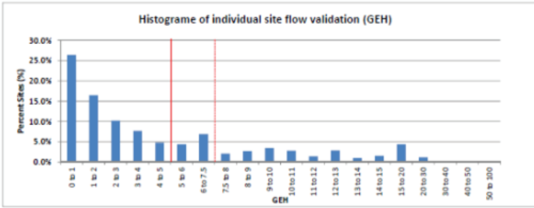
Source: DashBoard_WeLHAM_BY09_HS2_OOC_V4.sxlsx

Date 10/07/2013
Model version 26

WeLHAM Performance Dashboard - PM peak

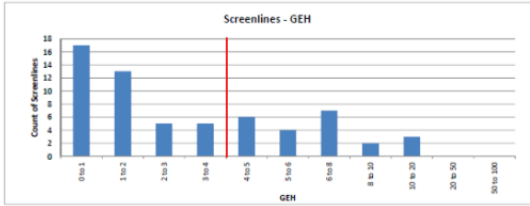
Counts Summary

	Total	%
No of counts	906	
criteria	619	68%
Counts with GEH <5	590	65%
Counts with GEH <7.5	691	76%



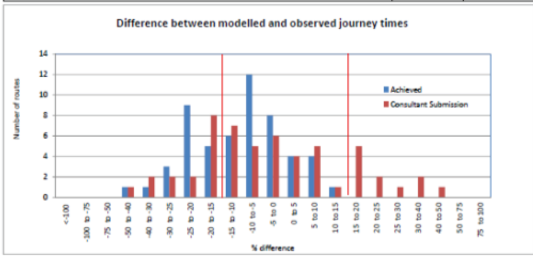
Screenline Summary

	Total	%
number	62	
flow		0%
nes with	43	69%
Screenlines with total flow error GEH<4	40	65%

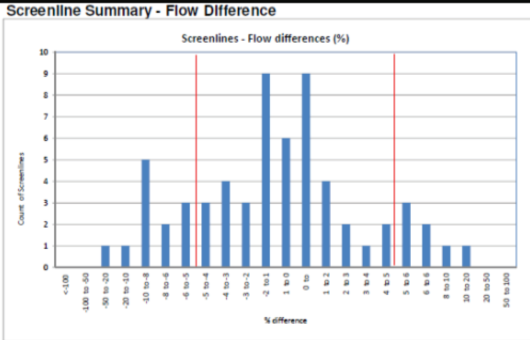


Journey Time Summary

	Total	%
Number of Routes	54	
(Modelled - Observed in	-11049	-13%
difference<15% or 1 min if	35	65%

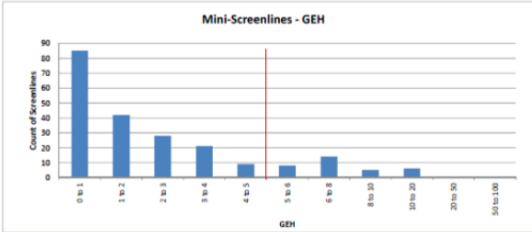


Screenline Summary - Flow Difference



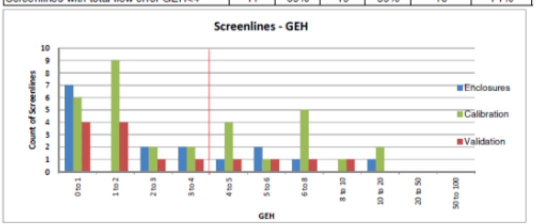
Mini Screenline Summary

	Total	%
screenlines	218	
mini screenlines		0%
difference <5%	131	60%
Mini screenlines with total flow error GEH<4	185	85%

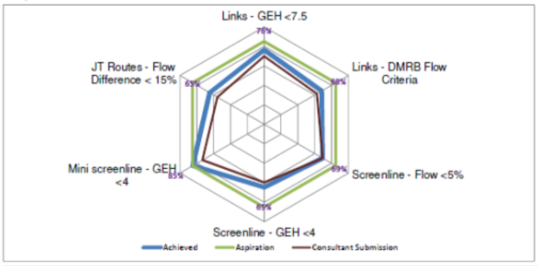


Screenline Summary by Type

	Enclosures		Calibration		Validation	
	Total	%	Total	%	Total	%
Total number of screenlines	16		32		14	
Total flow error across all screenlines		-3%		1%		-4%
Screenlines with flow difference <5%	10	63%	24	75%	9	64%
Screenlines with total flow error GEH<4	11	69%	19	59%	10	71%

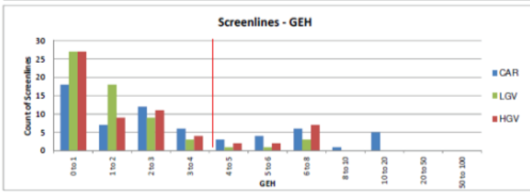


Top Line Statistics



Screenline Summary by Vehicle type

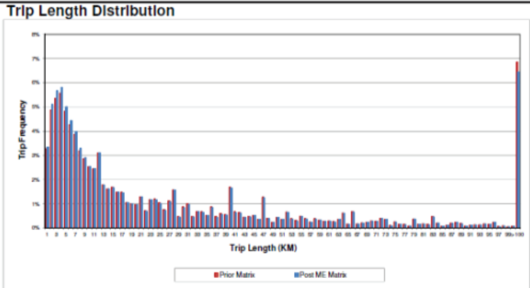
	Flow < 5%	GEH < 4
Car	65%	69%
LGV	65%	92%
HGV	34%	82%



Top Line Statistics

	Achieved	Aspiration	Consultant Submission
Links - GEH <7.5	76%	85%	70%
Links - DMRB Flow Criteria	68%	85%	63%
Screenline - Flow <5%	69%	85%	69%
Screenline - GEH <4	65%	85%	60%
Mini screenline - GEH <5	85%	85%	73%
JT Routes - Flow Difference < 15%	65%	85%	56%

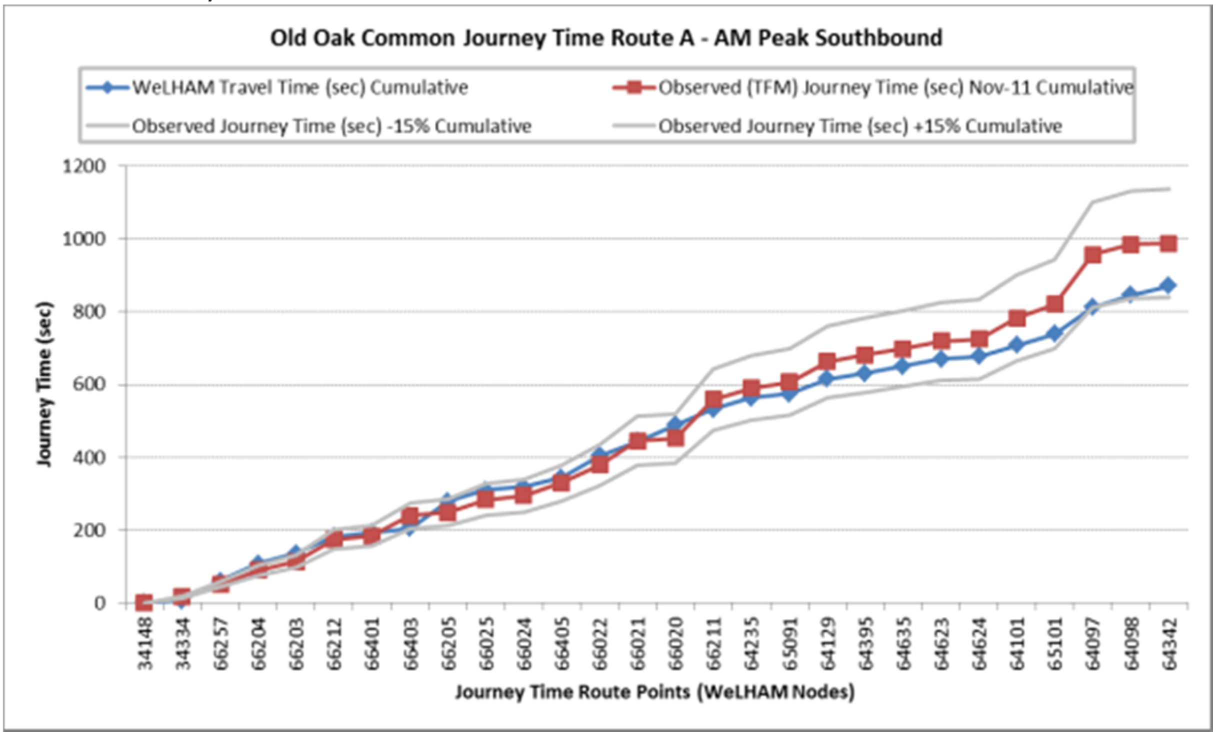
Trip Length Distribution

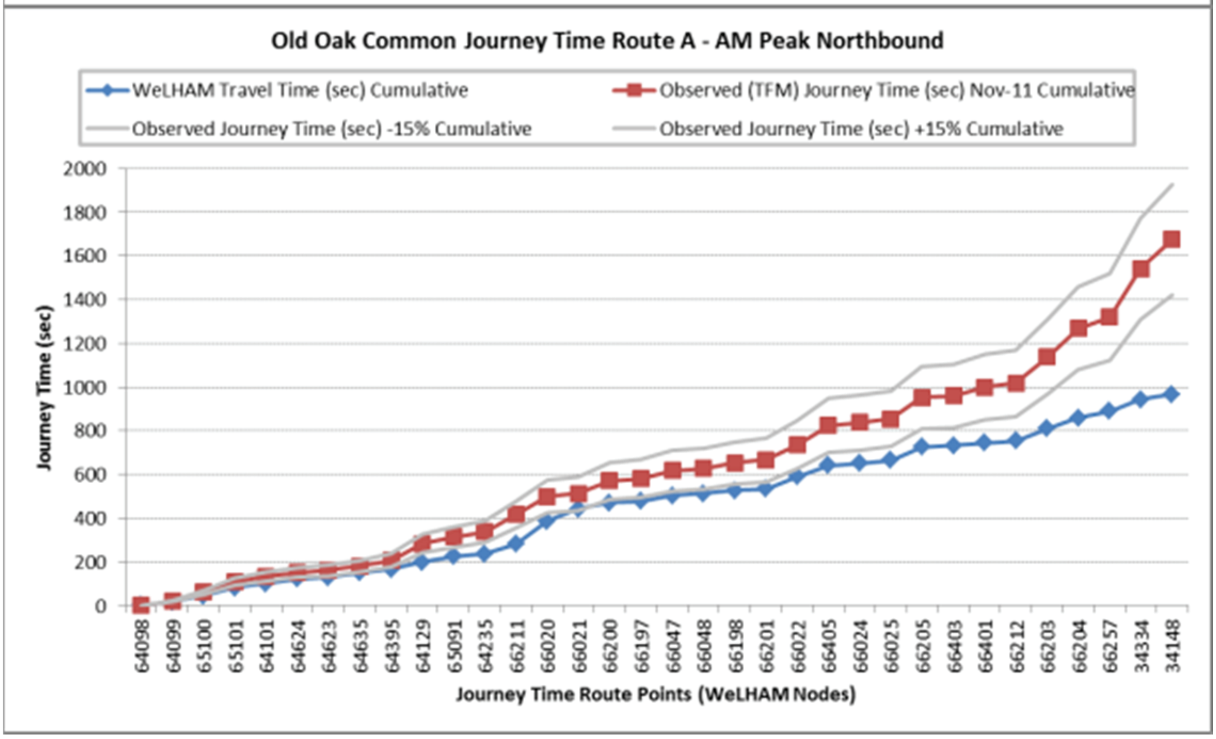


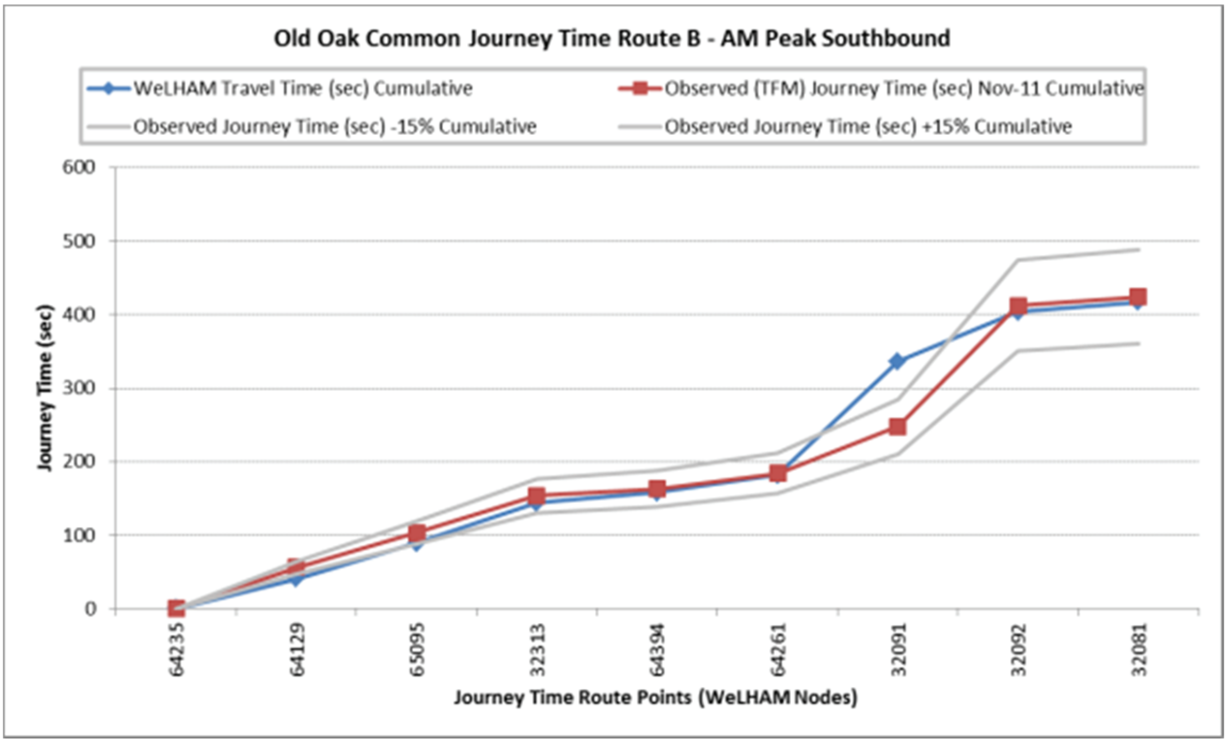
Source: DashBoard_WeLHAM_BY09_HS2_OOC_V4.xslx

Appendix H – Journey Time Graphs

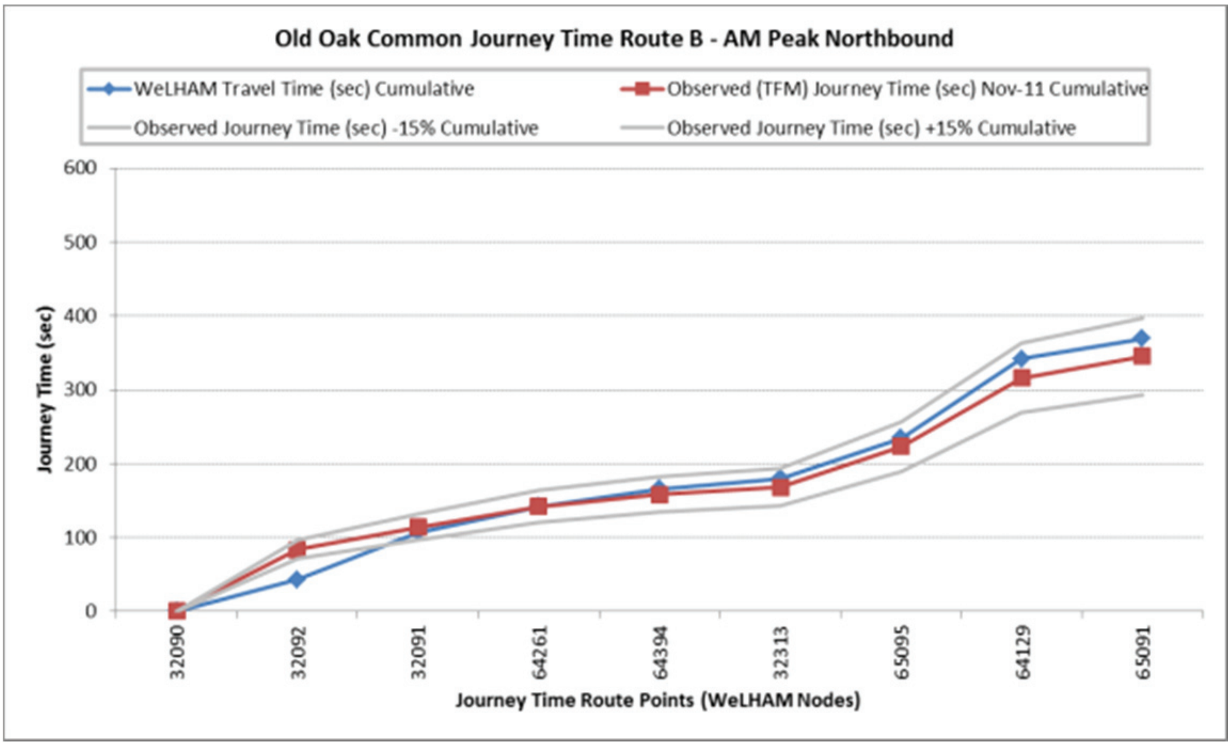
AM – OOC Study Area



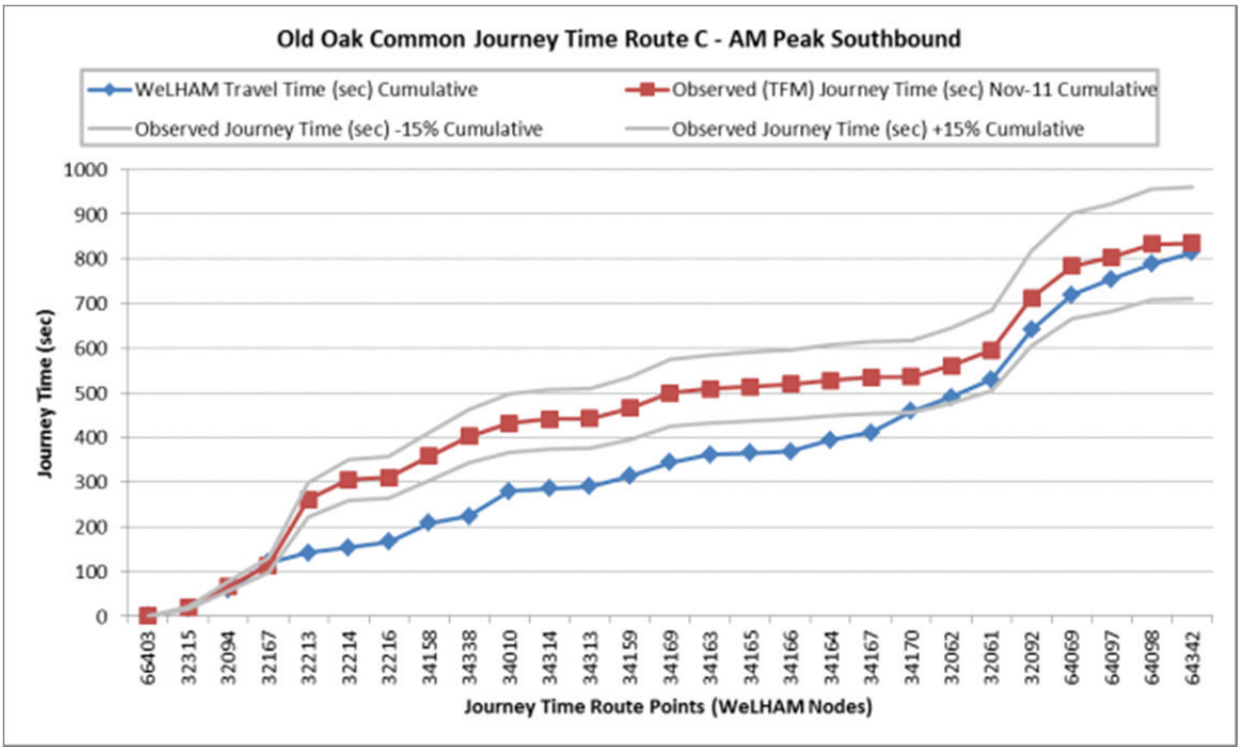


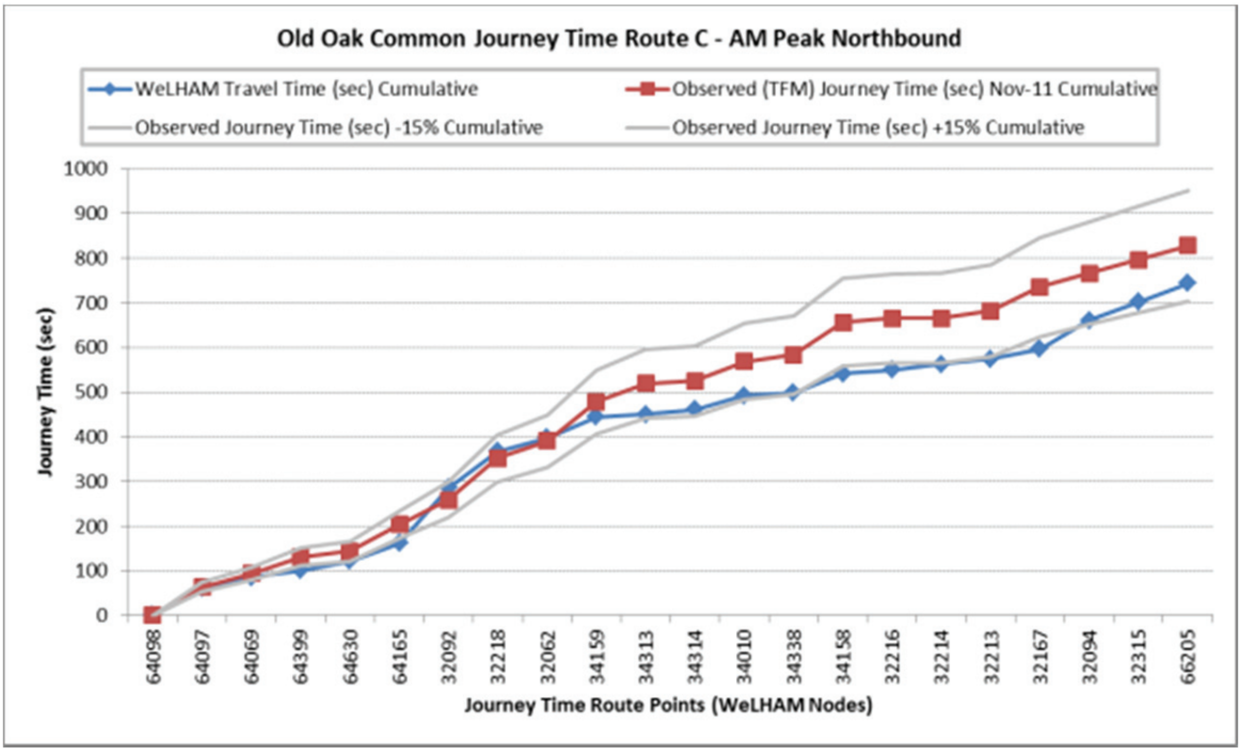


Old Oak Common Journey Time Route B - AM Peak Southbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
Journey Time (sec)
600
500
400
300
200
100
0
64235
64129
65095
32313
64394
64261
32091
32092
32081
Journey Time Route Points (WeLHAM Nodes)

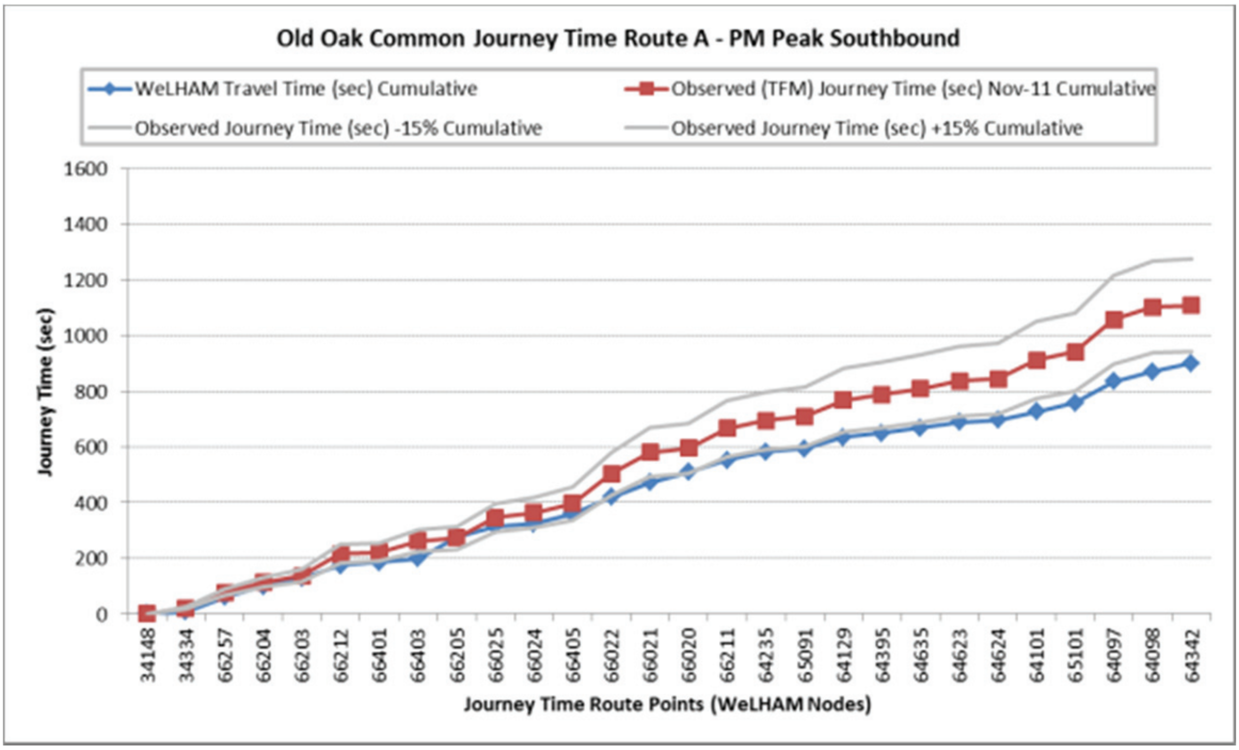


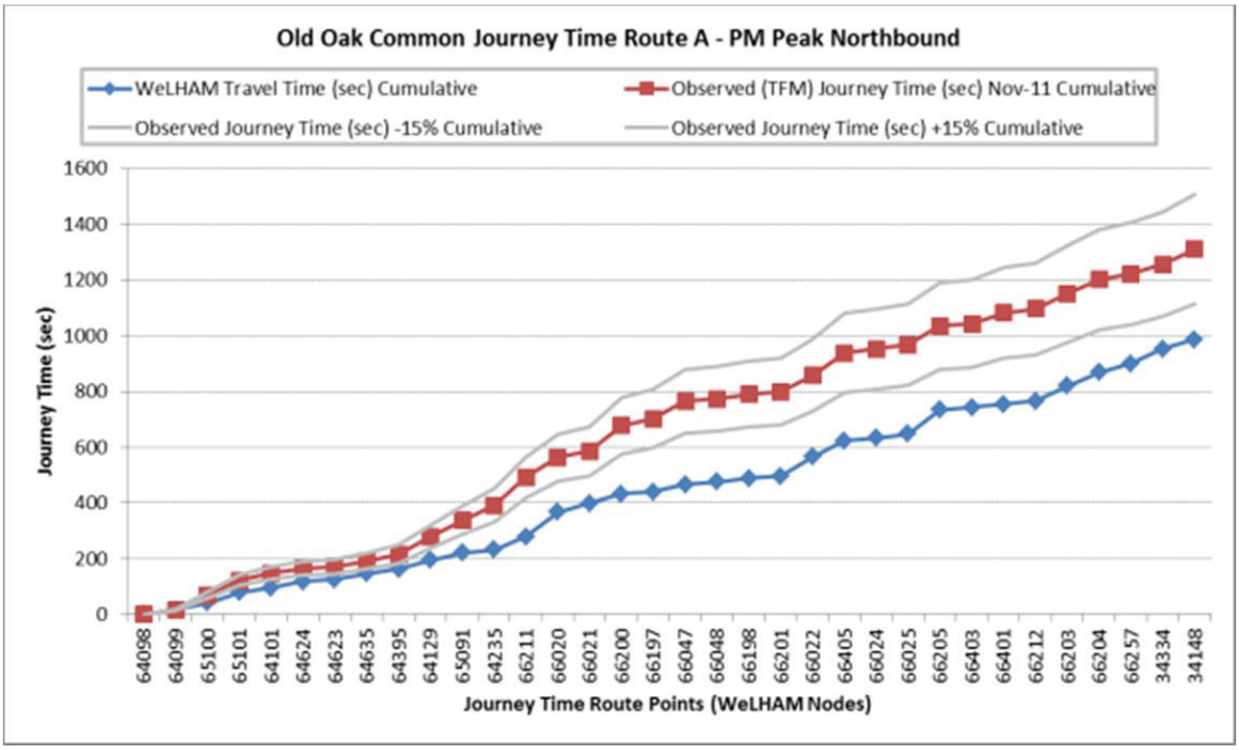
Old Oak Common Journey Time Route B - AM Peak Northbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
Journey Time (sec)
600
500
400
300
200
100
0
32090
32092
32091
64261
64394
32313
65095
64129
65091
Journey Time Route Points (WeLHAM Nodes)

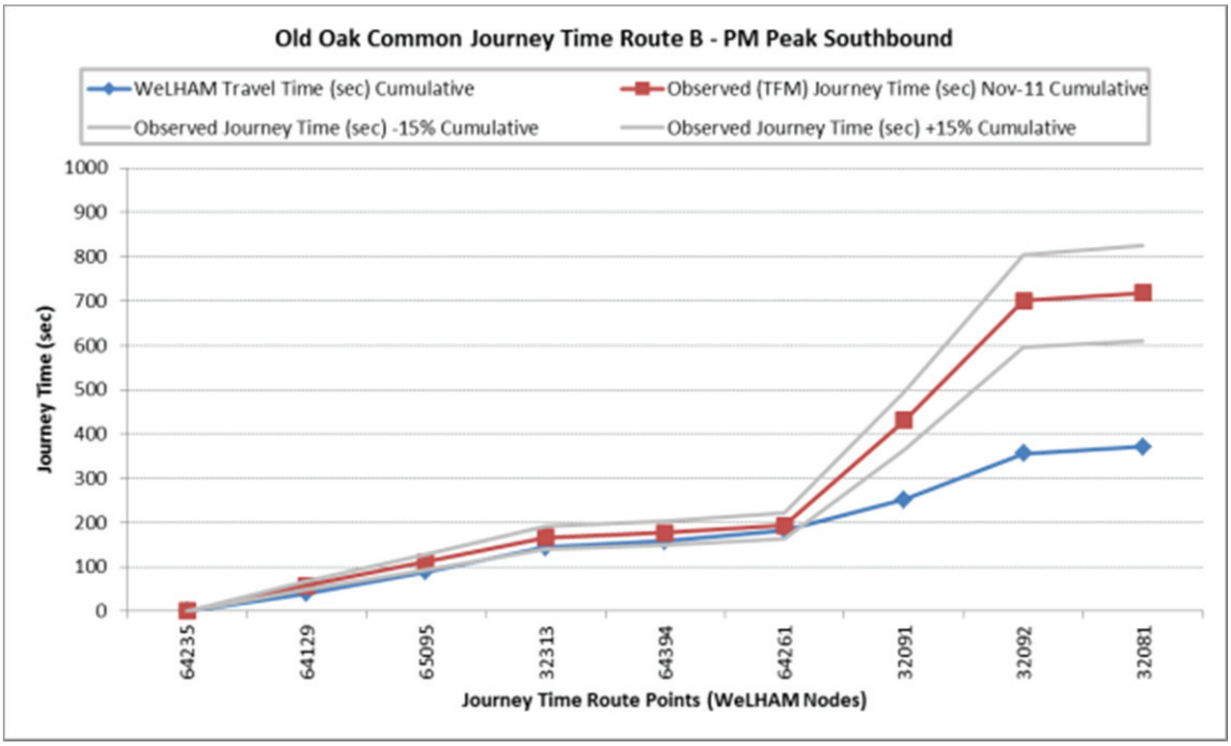

Old Oak Common Journey Time Route C - AM Peak Southbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
Journey Time (sec)
0
100
200
300
400
500
600
700
800
900
1000
66403
32315
32094
32167
32213
32214
32216
34158
34338
34010
34314
34313
34159
34169
34163
34165
34166
34164
34167
34170
32062
32061
32092
64069
64097
64098
64342
Journey Time Route Points (WeLHAM Nodes)


Old Oak Common Journey Time Route C - AM Peak Northbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
Journey Time (sec)
0
100
200
300
400
500
600
700
800
900
1000
64098
64097
64069
64399
64630
64165
32092
32218
32062
34159
34313
34314
34010
34338
34158
32216
32214
32213
32167
32094
32315
66205
Journey Time Route Points (WeLHAM Nodes)

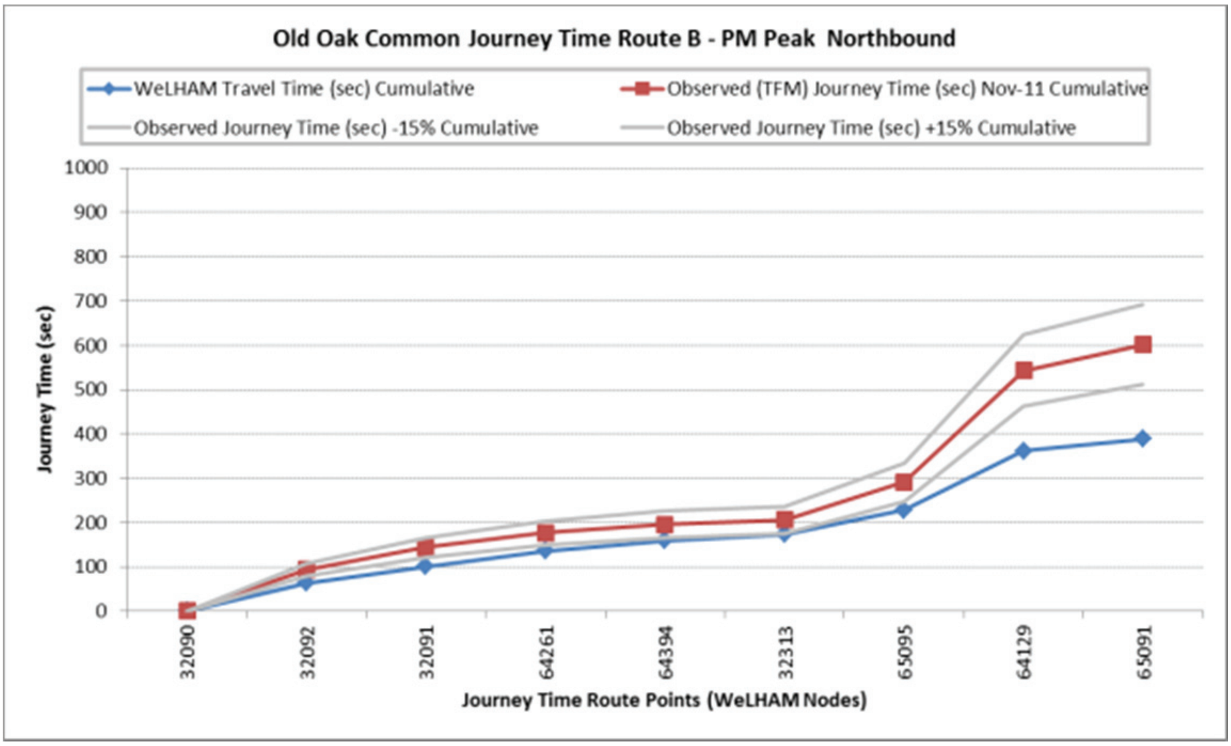
PM – OOC Study Area



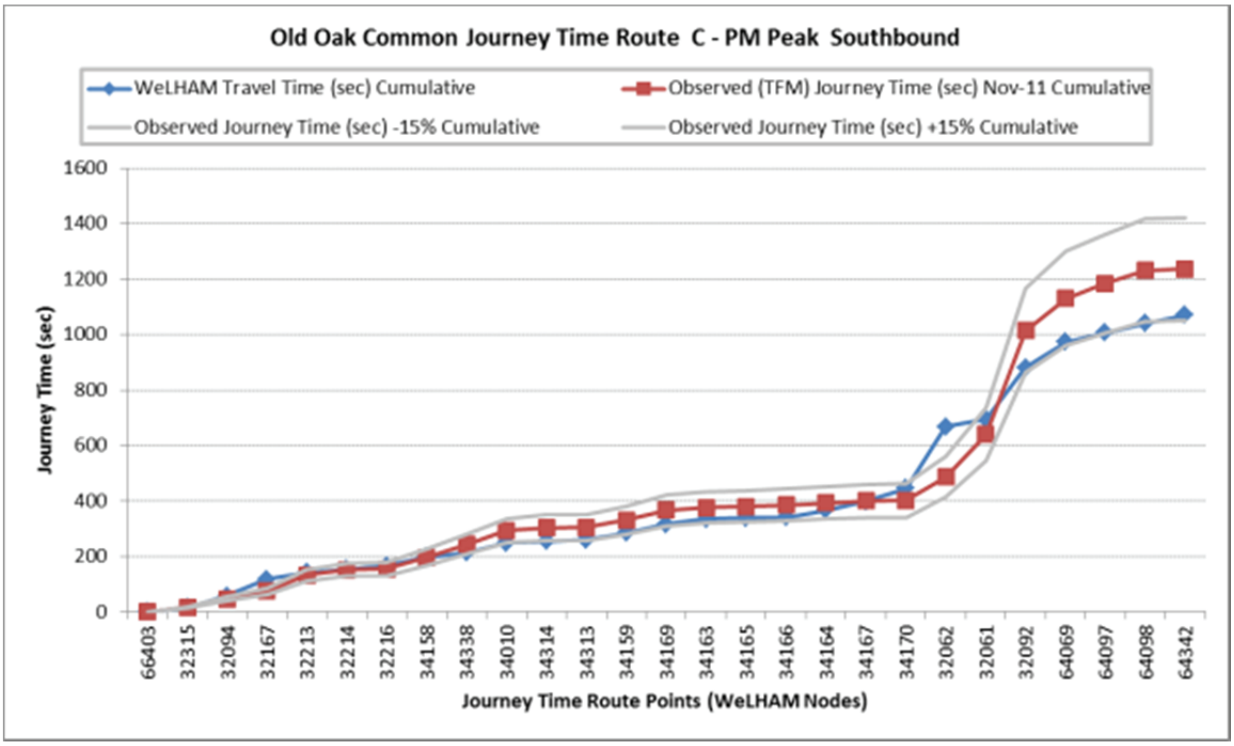


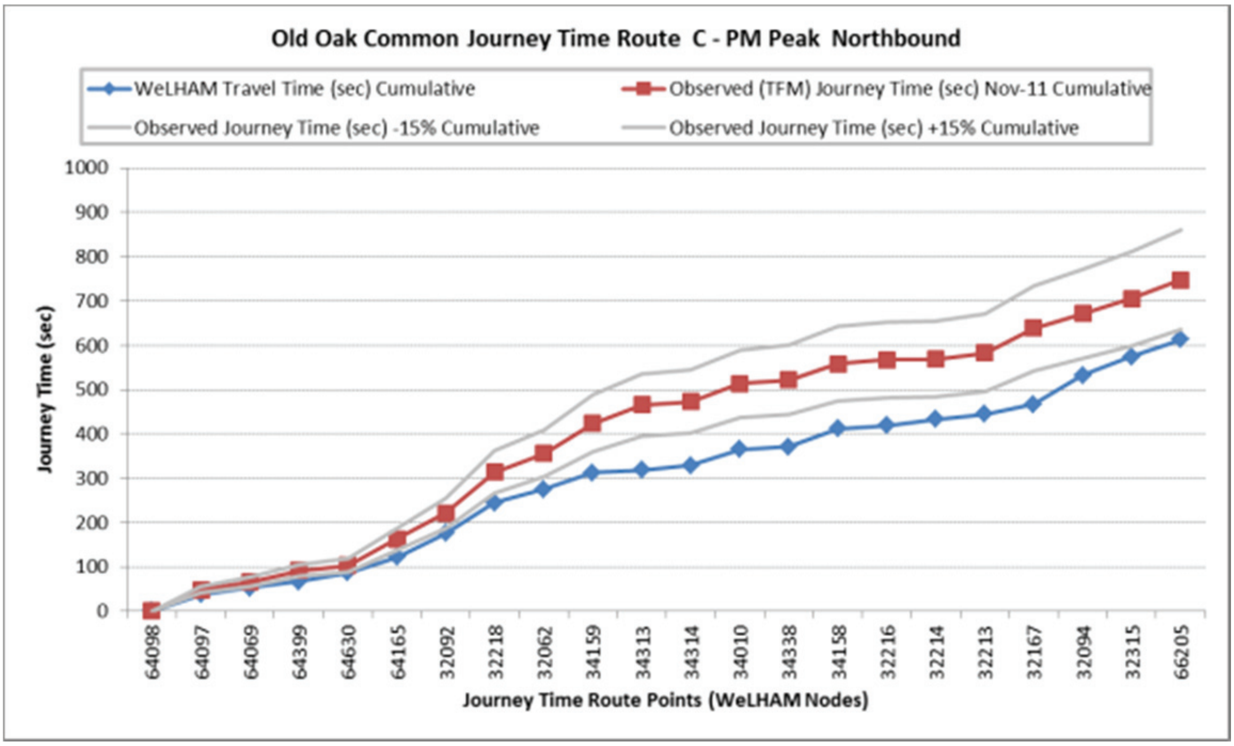


Old Oak Common Journey Time Route B - PM Peak Southbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
Journey Time (sec)
0
100
200
300
400
500
600
700
800
900
1000
64235
64129
65095
32313
64394
64261
32091
32092
32081
Journey Time Route Points (WeLHAM Nodes)

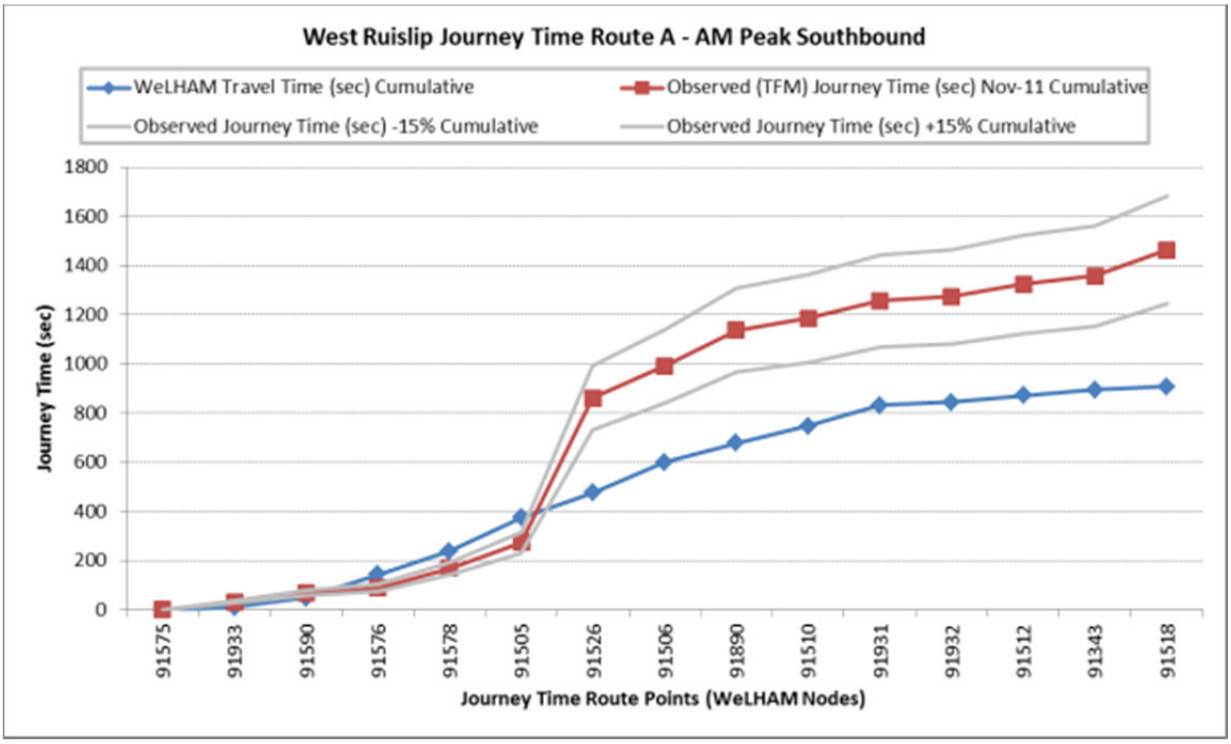


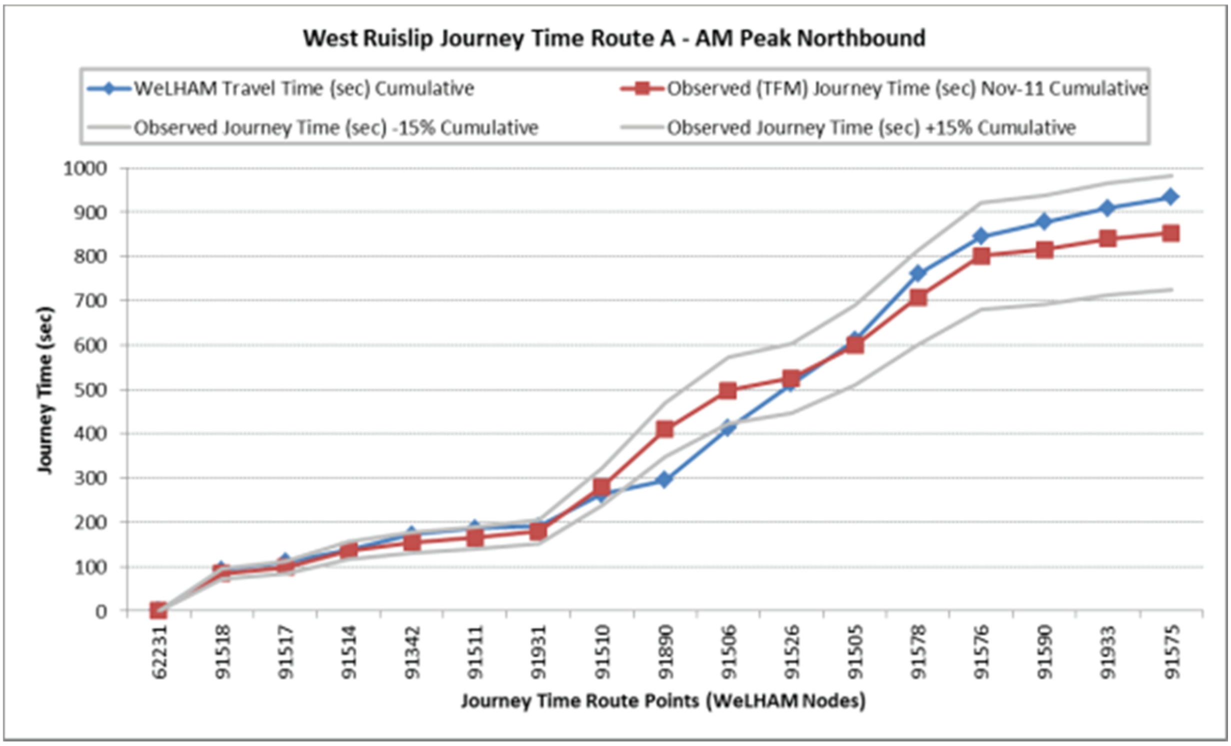
Old Oak Common Journey Time Route B - PM Peak Northbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
Journey Time (sec)
0
100
200
300
400
500
600
700
800
900
1000
32090
32092
32091
64261
64394
32313
65095
64129
65091
Journey Time Route Points (WeLHAM Nodes)

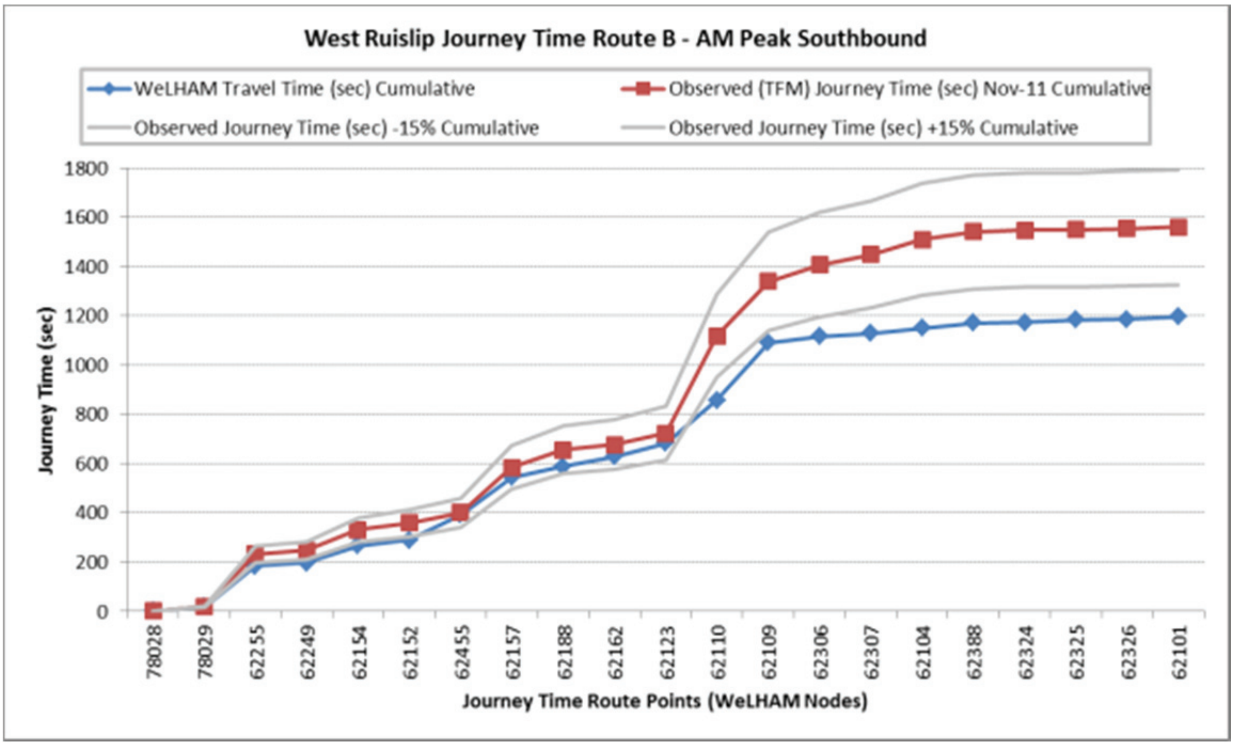

Old Oak Common Journey Time Route C - PM Peak Southbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
Journey Time (sec)
0
200
400
600
800
1000
1200
1400
1600
64403
32315
32094
32167
32213
32214
32216
34158
34338
34010
34314
34313
34159
34169
34163
34165
34166
34164
34167
34170
32062
32061
32092
64069
64097
64098
64342
Journey Time Route Points (WeLHAM Nodes)

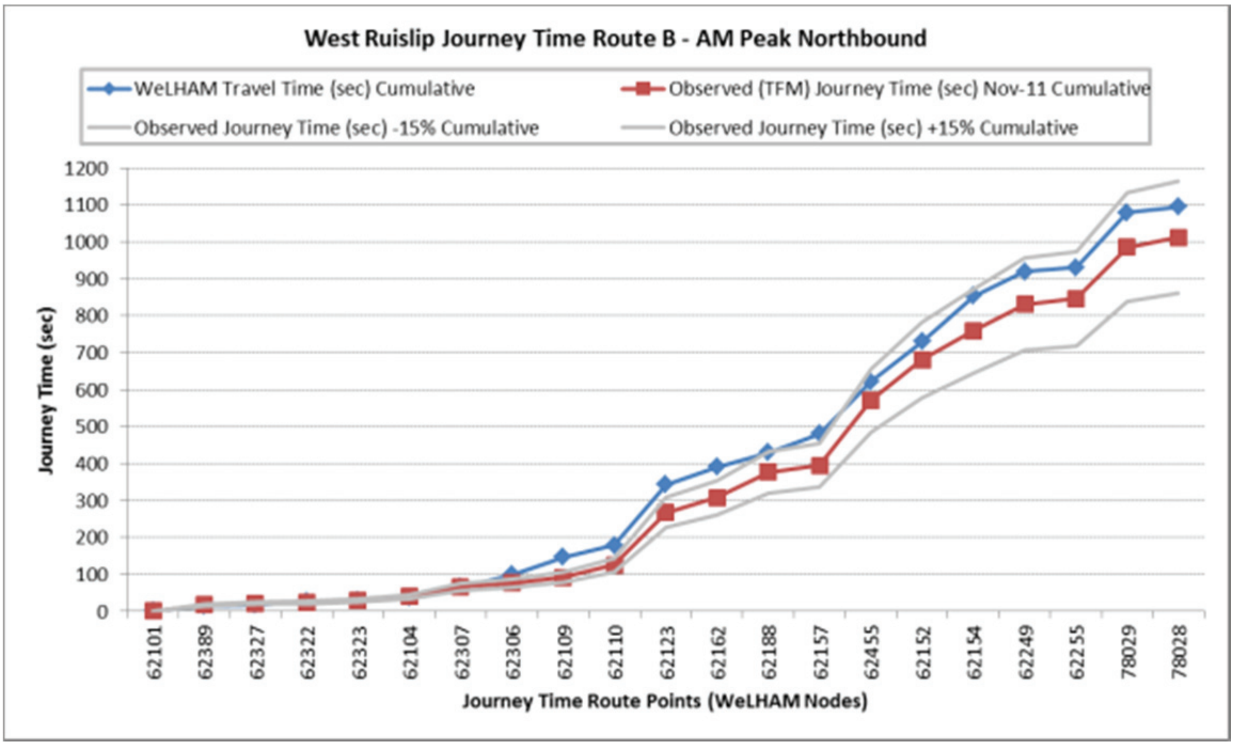

Old Oak Common Journey Time Route C - PM Peak Northbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
Journey Time (sec)
0
100
200
300
400
500
600
700
800
900
1000
64098
64097
64069
64399
64630
64165
32092
32218
32062
34159
34313
34314
34010
34338
34158
32216
32214
32213
32167
32094
32315
66205
Journey Time Route Points (WeLHAM Nodes)

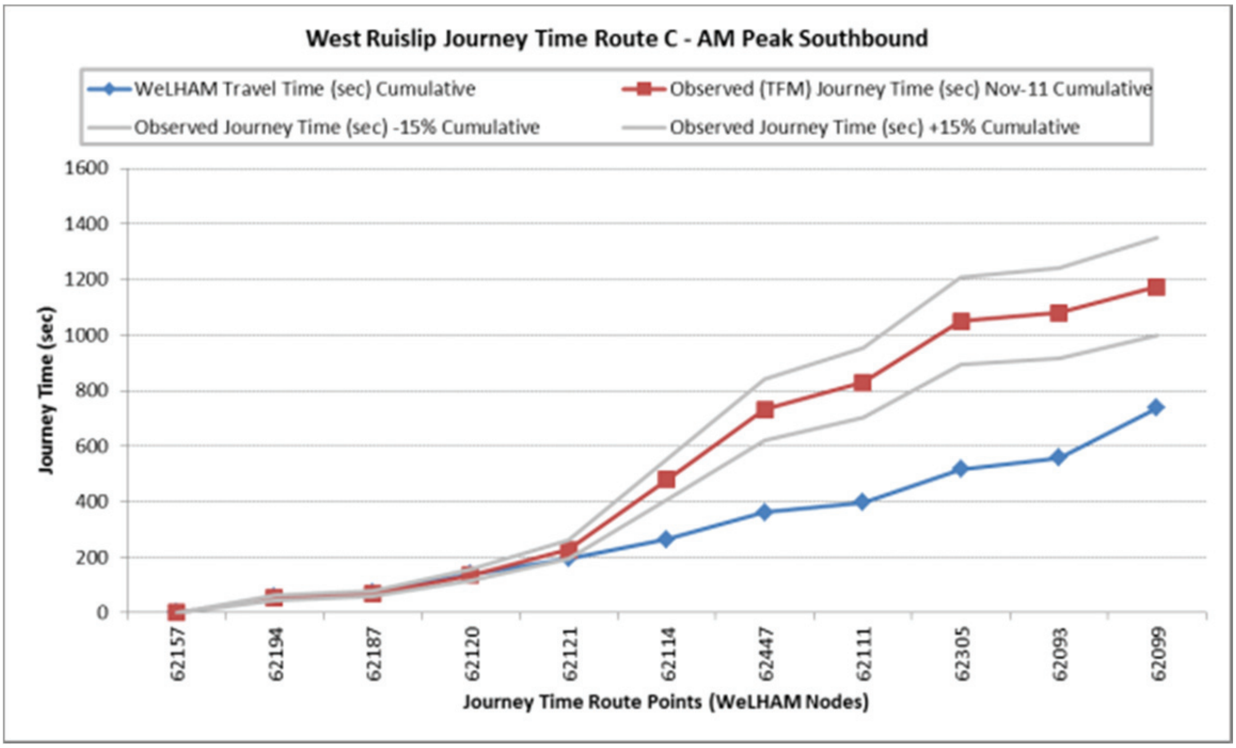
AM – West Ruislip Study Area

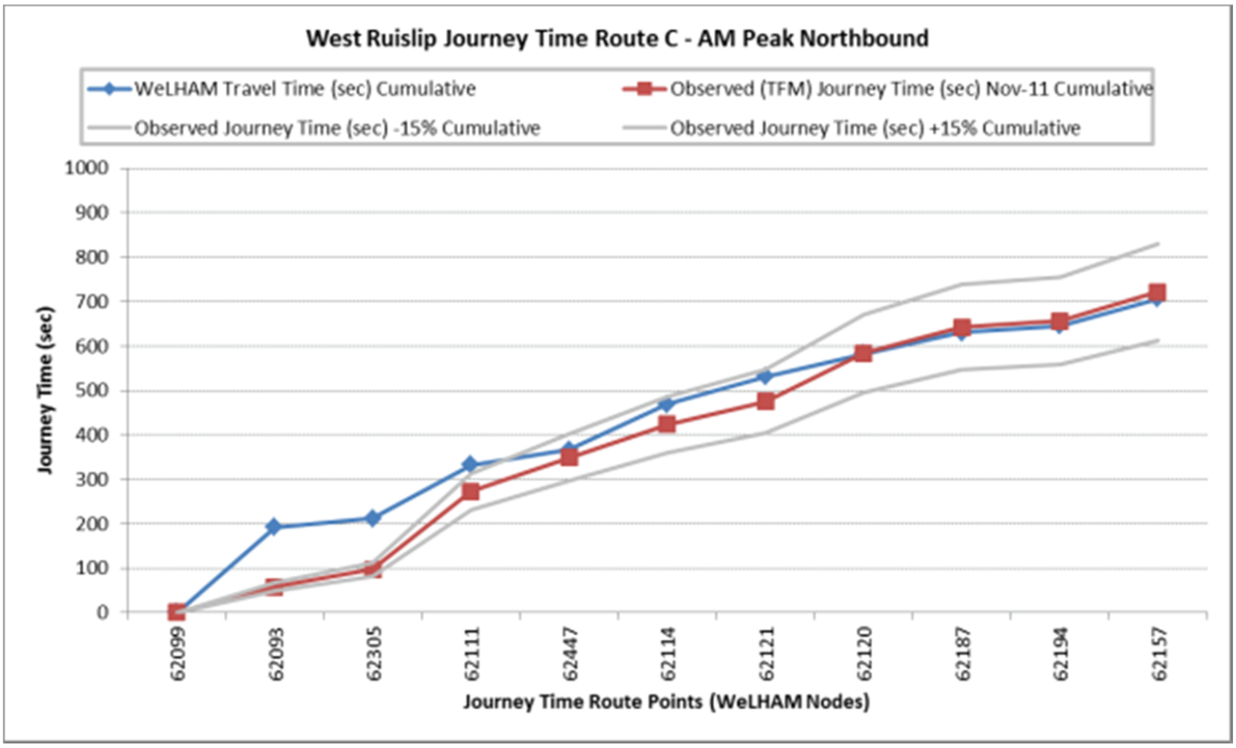




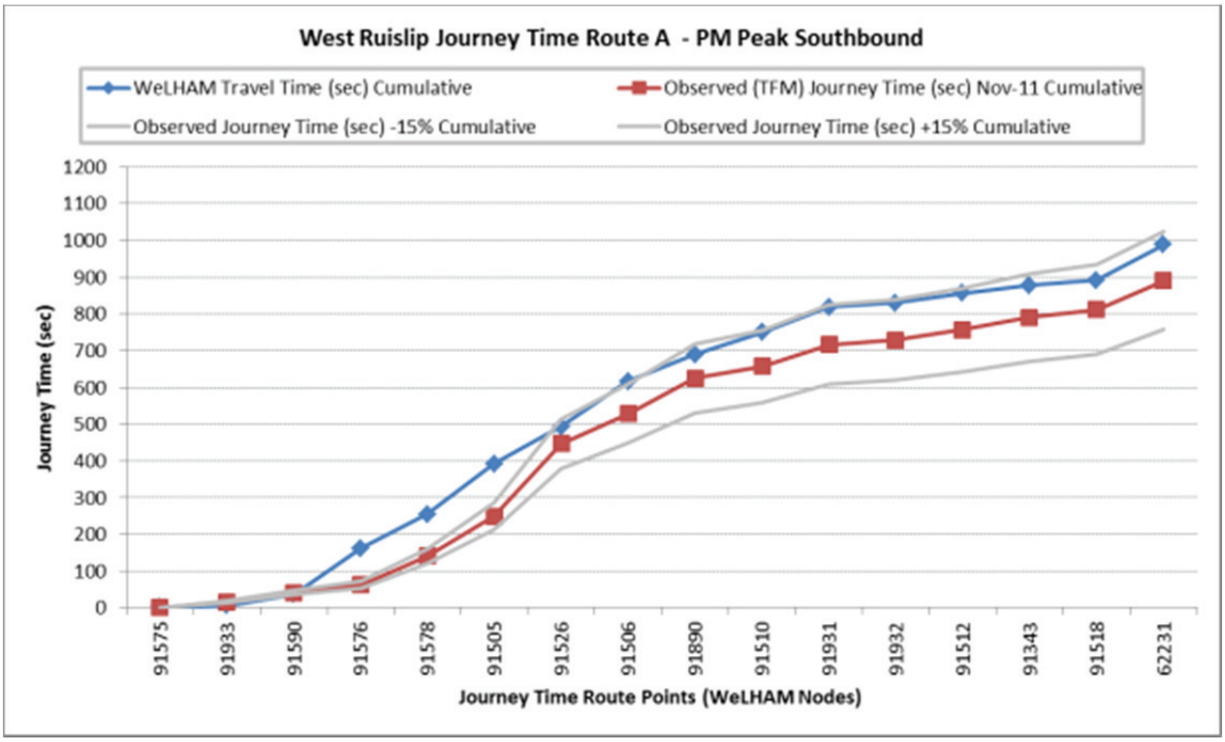

West Ruislip Journey Time Route B - AM Peak Southbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
Journey Time (sec)
1800
1600
1400
1200
1000
800
600
400
200
0
78028
78029
62255
62249
62154
62152
62455
62157
62188
62162
62123
62110
62109
62306
62307
62104
62388
62324
62325
62326
62101
Journey Time Route Points (WeLHAM Nodes)

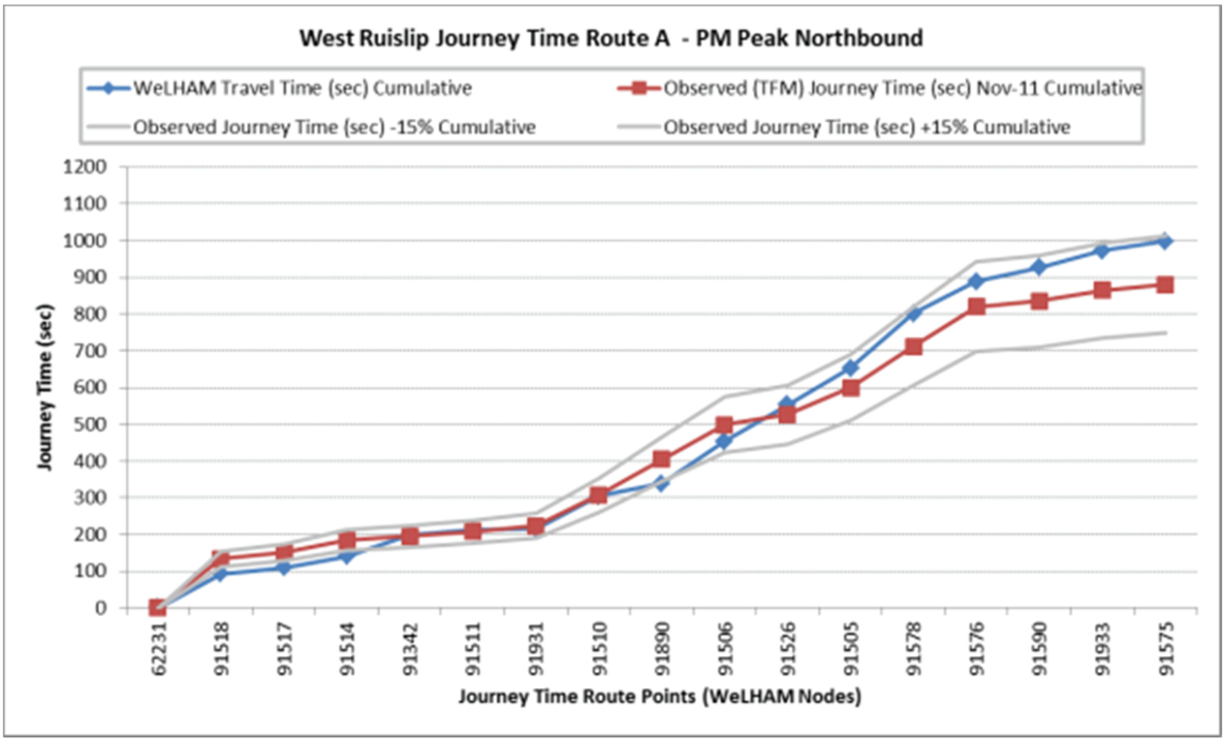

West Ruislip Journey Time Route B - AM Peak Northbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
Journey Time (sec)
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
62101
62389
62327
62322
62323
62104
62307
62306
62109
62110
62123
62162
62188
62157
62455
62152
62154
62249
62255
78029
78028
Journey Time Route Points (WeLHAM Nodes)

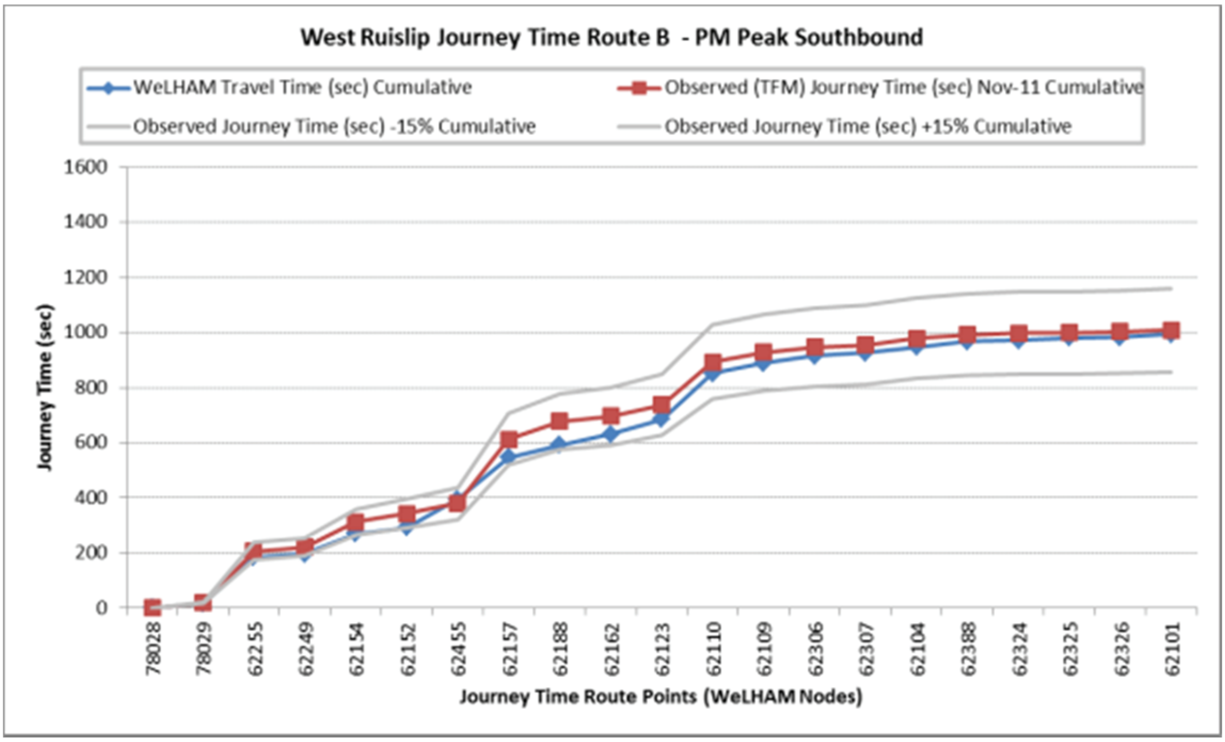

West Ruislip Journey Time Route C - AM Peak Southbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
Journey Time (sec)
0
200
400
600
800
1000
1200
1400
1600
62157
62194
62187
62120
62121
62114
62447
62111
62305
62093
62099
Journey Time Route Points (WeLHAM Nodes)


West Ruislip Journey Time Route C - AM Peak Northbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
Journey Time (sec)
0
100
200
300
400
500
600
700
800
900
1000
62099
62093
62305
62111
62447
62114
62121
62120
62187
62194
62157
Journey Time Route Points (WeLHAM Nodes)

PM – West Ruislip Study Area







West Ruislip Journey Time Route B - PM Peak Southbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
Journey Time (sec)
0
200
400
600
800
1000
1200
1400
1600
78028
78029
62255
62249
62154
62152
62455
62157
62188
62162
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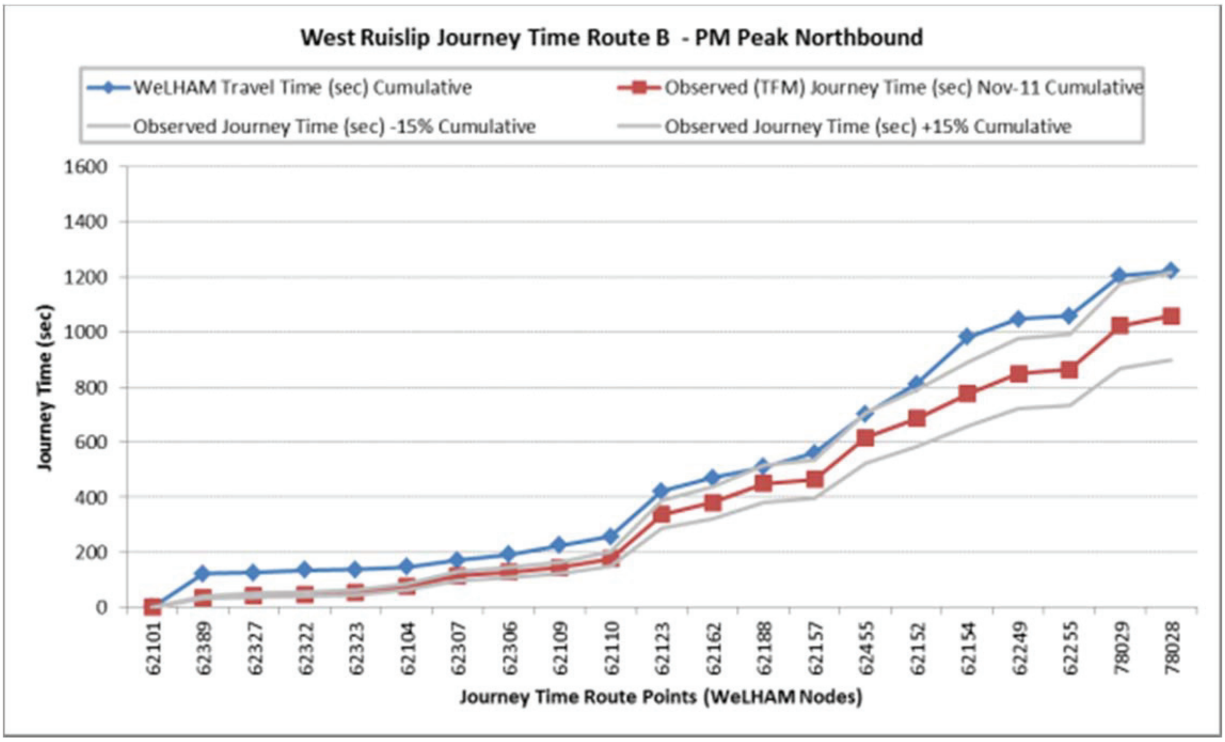
Journey Time Route Points (WeLHAM Nodes)



West Ruislip Journey Time Route B - PM Peak Northbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
Journey Time (sec)
0
200
400
600
800
1000
1200
1400
1600
62101
62389
62327
62322
62323
62104
62307
62306
62109
62110
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62162
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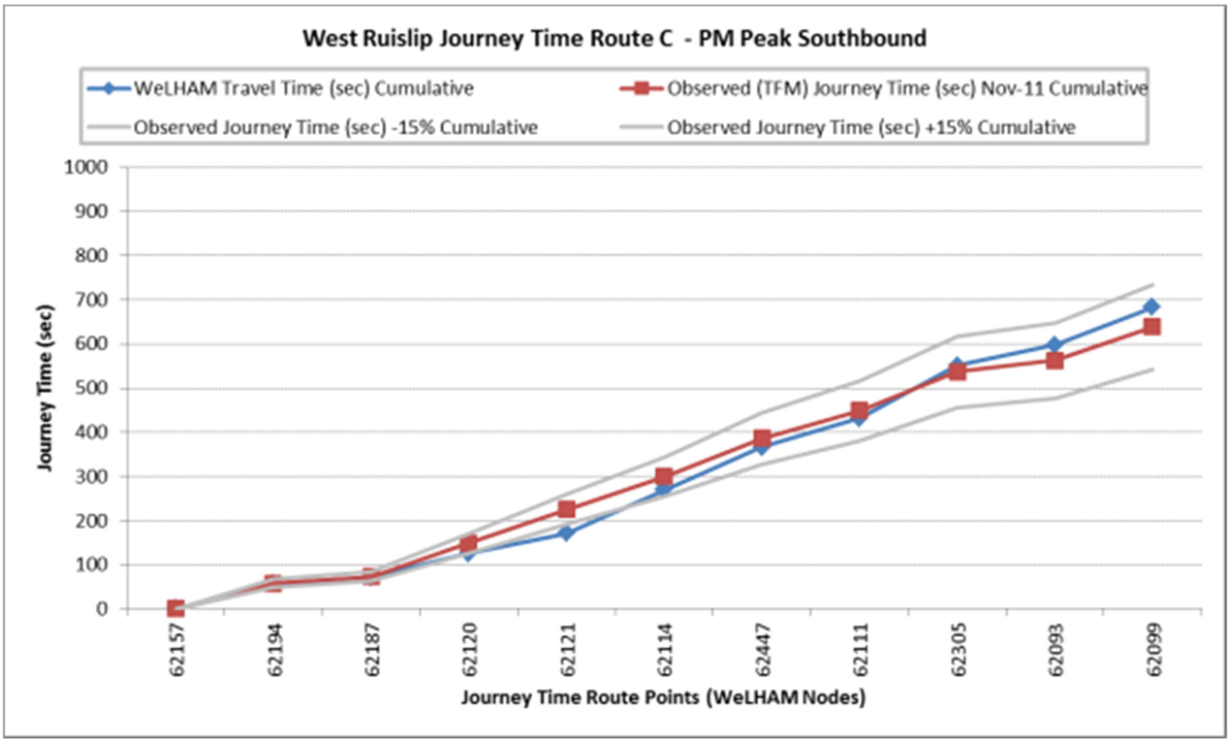
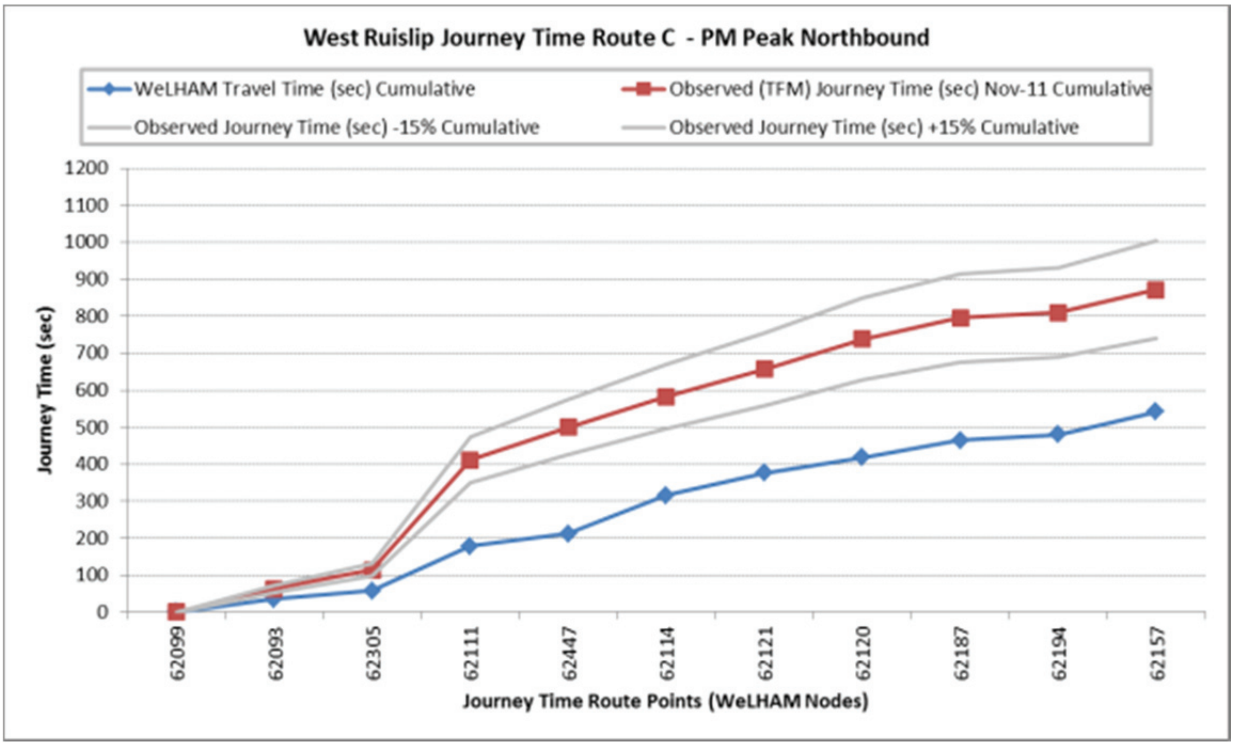
62152
62154
62249
62255
78029
78028
Journey Time Route Points (WeLHAM Nodes)


West Ruislip Journey Time Route C - PM Peak Southbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
Journey Time (sec)
1000
900
800
700
600
500
400
300
200
100
0
62157
62194
62187
62120
62121
62114
62447
62111
62305
62093
62099
Journey Time Route Points (WeLHAM Nodes)


West Ruislip Journey Time Route C - PM Peak Northbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
Journey Time (sec)
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
62099
62093
62305
62111
62447
62114
62121
62120
62187
62194
62157
Journey Time Route Points (WeLHAM Nodes)

Annex C(iv) - Euston Road (Region 8) TRANSYT Model Performance Working Paper

This annex contains the Euston Road (Region 8) TRANSYT modelling working paper prepared to describe the baseline TRANSYT modelling undertaken along Euston Road to assess the effects of the Proposed Scheme on the key junctions in the vicinity of Euston Station.

File Note

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Prepared by	[redacted]	Date	7 October 2013
Subject	Euston Road (Region 8) TRANSYT Modelling		

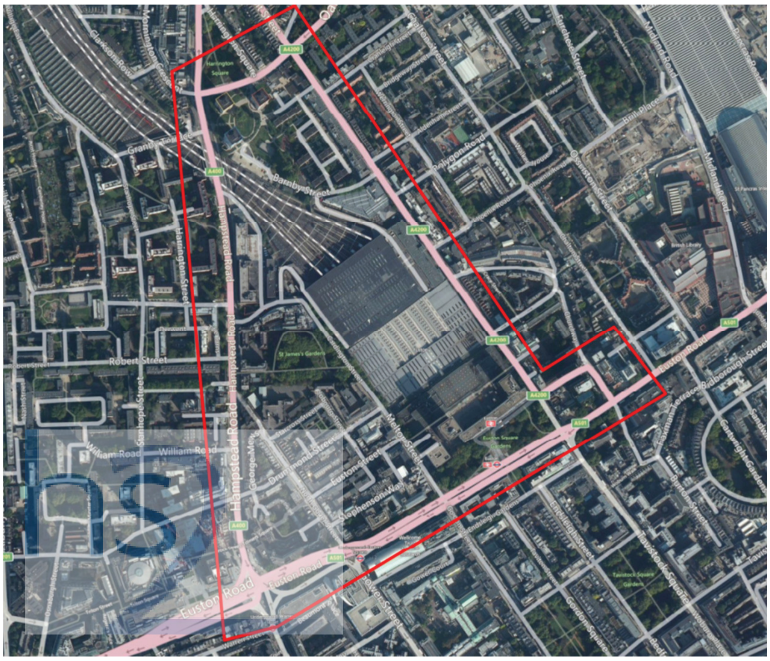
Table of Contents

1 Introduction

This report describes the baseline TRANSYT modelling undertaken along Euston Road to assess the effects of the Proposed HS2 Scheme (the Proposed Scheme) on the key junctions in the vicinity of Euston station. The area of influence is largely defined by the highway interventions and associated network changes due to the Proposed Scheme, as well as those junctions that are likely to experience a change in traffic flows in both the 2026 and 2041 operational scenarios.

The main area of area of interest surrounding Euston station is shown in **Figure 1**.

Figure 1: Euston Station Area of Interest



The TRANSYT model developed as part of the assessment of the Proposed Scheme was based on the Euston Road (Region 8) TRANSYT model provided by Transport for London (TfL).

1.1 Purpose of the Model

The Euston Road TRANSYT models have been developed to enable an assessment of the impacts of the Proposed Scheme on the local highway network. The assessment takes account of the impacts of increased traffic flows, both HGV and general traffic, and a new highway layout at the relevant junctions. The 2012 base models have been developed to provide a basis for this assessment so the capacity changes can be identified between the baseline and future year scenarios.

The modelling will support the Transport Assessment that is being prepared for the HS2 Hybrid Bill. The model has, therefore, been produced for planning stage. Further analysis will be

undertaken at detailed design stage and this will include full TRANSYT Model Audit Process (TMAP) models.

2 2012 Baseline Model

2.1 Model Scope

The Region 8 TRANYT model provided by TfL covers the length of Euston Road from Gordon Street / Melton Street as far as King's Cross Road and Pentonville Road and also includes the junctions of King's Cross Road with Penton Rise and Gray's Inn Road with Swinton Street. Cardington Street and Eversholt Street (as far as Barnby Street) are also included in the TRANSYT model. The full scope of the model can be seen in **Figures 2** and **3**.

Figure 2: TRANSYT Model Study Area

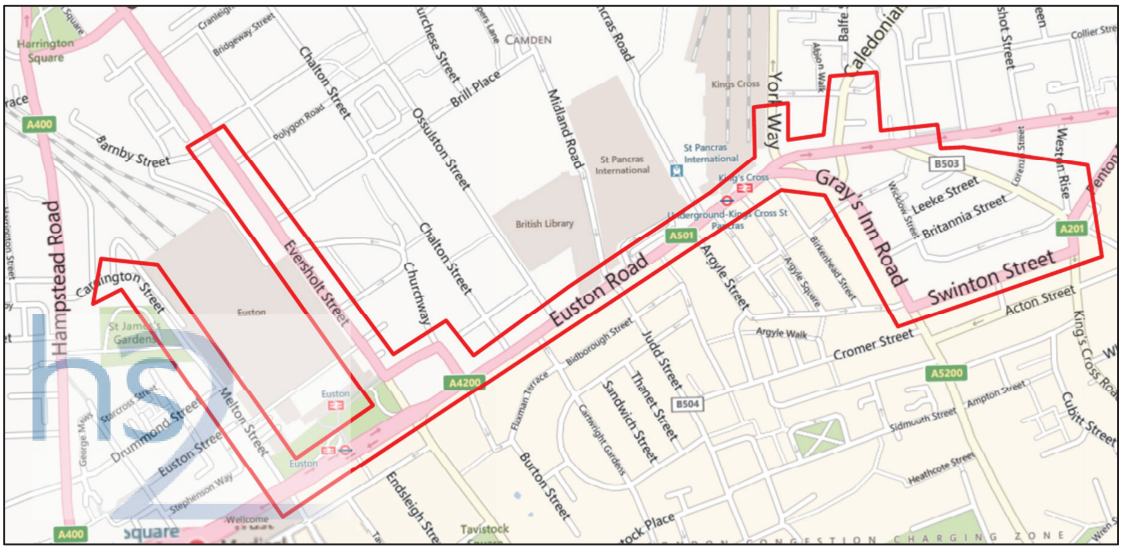
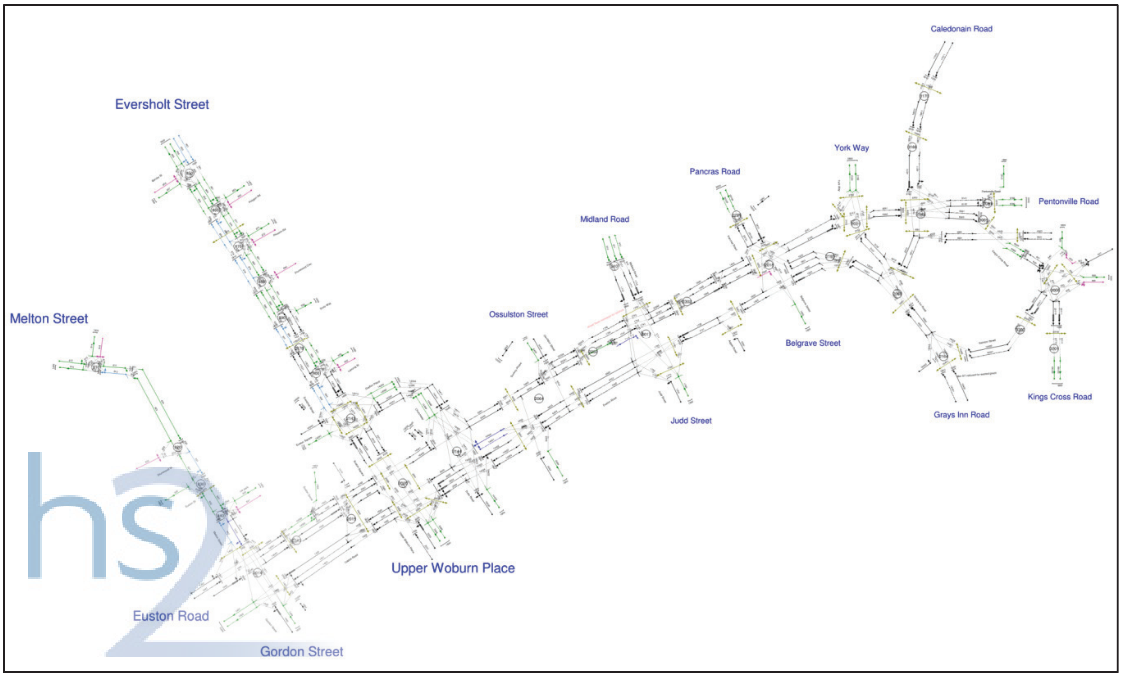


Figure 3: Euston Road TRANSYT Model



The Euston Road 2012 Baseline TRANSYT model includes the junctions listed in **Table 1**.

Table 1: Junctions in Euston Road TRANSYT Base Model

Node Number	Junction	Control Type
810	Cardington Street / Euston Station Servicing Access	Priority
820	Cardington Street / Drummond Street	Priority
830	Cardington Street (Melton Street) / Euston Street	Priority
840	Melton Street / Euston Station Taxi Access	Priority
2014	Euston Road / Melton Street / Gordon Street	Signalised
2145	Euston Road (East of Melton Street) Eastbound - Pedestrian Crossing	Signalised
2015	Euston Road / Euston Square Gardens (Bus Station)	Signalised
2020	Euston Road / Upper Woburn Place / Euston Square (East)	Signalised
2143	Eversholt Street / Grafton Place / Bus Station	Signalised
900	Eversholt Street / Lancing Street	Priority

Node Number	Junction	Control Type
2178	Eversholt Street (North of Lancing Street) – Pedestrian Crossing	Signalised
890	Eversholt Street / Doric Way	Priority
880	Eversholt Street / Drummond Crescent	Priority
870	Eversholt Street / Phoenix Road	Priority
860	Eversholt Street / Polygon Road	Priority
850	Eversholt Street / Barnby Street	Priority
2144	Euston Road / Churchway / Grafton Place	Signalised
2064	Euston Road / Mabledon Place / Ossulston Street	Signalised
2202	Euston Road (East of Ossulston Street) Eastbound – Pedestrian Crossing	Signalised
2017	Euston Road / Midland Road / Judd Street	Signalised
2302	Euston Road (East of Midland Road) Eastbound – Pedestrian Crossing	Signalised
2018	Euston Road / Pancras Road / Argyle Road	Signalised
2291	Pancras Road – Pedestrian Crossing	Signalised
2193	Euston Road / Gray's Inn Road	Signalised
2069	Gray's Inn Road / King's Cross Bridge	Signalised
2164	Gray's Inn Road / Swinton Street	Signalised
3200	Swinton Street – Pedestrian Crossing	Signalised
3201	King's Cross Road (South of Vernon Rise) – Pedestrian Crossing	Signalised
3006	King's Cross Road / Penton Rise	Signalised
3069	Pentonville Road / King's Cross Road	Signalised

Node Number	Junction	Control Type
3081	Pentonville Road – Pedestrian Crossing	Signalised
2049	Pentonville Road / Caledonian Road	Signalised
3188	Caledonian Road – Pedestrian Crossing	Signalised
3170	Caledonian Road – Pedestrian Crossing	Signalised
2021	Euston Road / York Way	Signalised

Considering the Proposed Scheme and the re-development of Euston station, the key junctions considered are:

- Euston Road / Gordon Street / Melton Street;
- Euston Road / Euston Square Gardens (Bus Station Entrance/Exit);
- Euston Road / Upper Woburn Place / Euston Square;
- Eversholt Street / Grafton Place / Bus Station Entrance/Exit); and
- Euston Road / Churchway / Dukes Road.

While these junctions are the key junctions analysed as part of the assessment of the Proposed Scheme, the full model, as provided by TfL, has been used in this assessment.

2.2 Model Scenarios

The Region 8 TRANSYT model provided by TfL assessed two scenarios, namely:

- 2009 AM peak hour (08:00 to 09:00); and
- 2009 PM peak hour (17:00 to 18:00).

To assess the Proposed Scheme, the models have been updated to a 2012 Baseline scenario using traffic flows collected as part of a series of surveys undertaken in June 2012. However, the modelled time periods are the same as those of the TfL TRANSYT models.

2.3 Link Structure

The link structure for the 2012 Baseline models remains largely unchanged from the 2009 TRANSYT models provided by TfL. The only minor change implemented was on Links 1844, 1845 and 1846 where the control type was changed from a signal controlled link to a bottleneck link. This was undertaken as the links are not at a stop line and the queueing on the mid-link section was found to be significantly greater than the queueing at the stop line.

2.4 Saturation Flows

The saturation flows for the 2012 Baseline TRANSYT models were not modified from those of the TRANSYT models received from TfL.

2.5 Model Calibration

This section described the process undertaken to calibrate the 2012 Baseline TRANSYT models. The calibration process was undertaken based on the 2009 TRANSYT models provided by TfL. The calibrate 2012 Baseline models have been provided to support this report. The model files are:

- R008 2012_AM_20130522_UTC.tnd; and
- R008 2012_PM_20130522_UTC.tnd.

2.5.1 Staging, Phasing, Intergreens, Minimum Greens and Phase Delays

The signal control data in the TRANSYT models received from TfL were compared against the signal timing sheets, also provided by TfL. To ensure consistency, the AM and PM peak hour models were updated so that the signal control data were consistent with the signal timing sheets. This included checking and updating, where appropriate, the following:

- Signal staging and phasing;
- Intergreens;
- Minimum greens; and
- Phase delays.

A number of the nodes in the TfL models also contained bonus greens which were removed as part of the calibration process. Bonus greens were re-introduced to provide additional right turn capacity at appropriate locations and also to ensure that the presence of cyclists and advanced stop lines (ASL) for cyclists (see **Section 3.5.4**) were modelled appropriately.

The staging, phasing, intergreen, minimum green and phase delay data that was updated from that of the model provided by TfL are detailed in the accompanying spreadsheet titled ‘TRANSYT Model Checking v1.xlxs’. The signal timing sheets as well as the site layout drawings (SLD), as provided by TfL, are also provided to support his report.

2.5.2 Signal Timing Data

As part of the model calibration process, the 2012 Baseline TRANSYT models were updated so that the first model run accounted for the signal timings provided on the UTC Background Plans, supplied by TfL. This process was undertaken to ensure that prior to validating the models, the signal information was input to the models and running as would be expected without SCOOT in operation.

The UTC background data, as supplied by TfL, has been provided to support this report.

2.5.3 Demand Dependency

Demand dependency data for the day of the traffic surveys in June 2012 were obtained from TfL. During the AM and PM peak hours, eight nodes were found to have demand dependent stages that were not call in every cycle.

These nodes were:

- Node 2144 – Euston Road/Churchway/Dukes Road;
- Node 2178 – Eversholt Street pedestrian crossing north of Lancing Street;
- Node 3170 – Caledonian Road (south of Northdown Road) pedestrian crossing;
- Node 3188 – Caledonian Road (south of Balfe Street) pedestrian crossing;
- Node 3081 – Pentonville Road pedestrian crossing;
- Node 3069 – King's Cross Road (north of Swinton Street) pedestrian crossing;
- Node 3200 – Swinton Street pedestrian crossing; and
- Node 3201 – King's Cross Road (south of Swinton Street) pedestrian crossing.

One additional node had a demand dependent stage that was not called during the AM and PM peak hours. This was Node 2018 (Euston Road / Pancras Road).

The green time at all demand dependent nodes was adjusted to account for demand dependent stages. Where the green time was already running to a minimum (at pedestrian crossings) the minimum greens (and in one instance (at node 3201 during the PM peak hour), the intergreens) were adjusted to allow the green time to be reduced sufficiently to account for demand dependency.

The demand dependency data, as supplied by TfL and the demand dependency calculations (in the spreadsheet titled 'Euston Road Demand Dependency Calcs.xlsx') have been provided to support this report.

2.5.4 Cyclists

Cyclists have been represented in the modelled traffic flows by assigning a PCU value of 0.2 to each cyclist counted during the 2012 traffic surveys. In addition, the presence of cyclists at ASLs has been modelled using a two second negative bonus green at all relevant stop lines. This has been undertaken in accordance with TfL's *Traffic Directorate Interim Guidance Note: Modelling Cycle Super-Highways*. It should be noted that the saturation flows were not adjusted to account for cycle lanes or the presence of cyclists.

2.5.5 Underutilised Green Time

Underutilised green time has not been explicitly modelled at every junction in the model. However, as discussed in **Section 2.5.4**, where ASLs are present or a large number of cyclists use a stop line, a two second negative bonus green has been applied to represent the delay to traffic caused by cyclists. In addition, during the AM peak hour, a 30 second phase delay has been applied to Links 1420 and 1421 (Euston Road East (westbound movement) at the junction of Euston Road with Melton Street and Gordon Street) to replicate the observed queuing caused by blocking back at this junction.

Although blocking back has been observed on occasion at other locations, video observation has shown that the recorded queues can generally be accommodated within the available carriageway space.

2.6 Traffic Flows

The traffic flows used in developing the 2012 Baseline TRANSYT models are those collected in the traffic surveys undertaken on 26 June 2012. The surveys covered all the key junctions outlined in **Section 3.1** as well as the junctions along Melton Street, Cardington Street and Eversholt Street.

In terms of lane usage, the traffic flows were allocated on a lane-by-lane basis. The link structure of the model is set up such that bus lane usage and taxi, motorcycle and pedal cycle (in equivalent passenger car unit (PCU) values) is modelled separately. As such, the proportion of the taxi, motorcycle and pedal cycle PCU flows was allocated to these lanes based on the actual lane usage derived from the traffic survey data.

As the traffic surveys did not extend to the east beyond the junction of Euston Road with Pancras Road, no 2012 traffic flow data is available for these junctions. In order to calculate the flows through this section of the network, the entry and exit flows on the eastern arm of the Euston Road junction with Pancras Road were distributed through the network. The turning movements at the junctions in this section of the network were then calculated using the original turning movement proportions from TfL's 2009 TRANSYT model.

The flows were then balanced at the junction of King's Cross Road with Swinton Street and Penton Rise.

All the traffic survey information used to construct the TRANSYT model has previously been provided to TfL.

2.7 Model Validation

2.7.1 Introduction

The validation of the 2012 Baseline AM and PM peak hour models was undertaken using a two stage process. Stage 1 involved the collection of stage length data from TfL and adjusting the stage lengths in the model to replicate this. Stage 2 involved a further adjustment of the signal timings so that the model accurately represented the queue lengths and journey time data obtained as part of the June 2012 surveys.

As the network being models has not changed to any significant degree the saturation flows were unchanged from the received TfL's 2009 TRANSYT model. For the purposes of validating a model at this stage of the design process, achieving a model that is validated for queues and journey times was deemed appropriate. A more detailed validation exercise will be undertaken when the scheme progresses to detailed design stage.

2.7.2 Stage 1

Given that SCOOT operates along Euston Road, stage length data were obtained from TfL's ASTRID database. This database records the actual stage length and cycle times for each stage at each junction. However, on investigation of the ASTRID database, it was found that stage length data was not available on the day that the traffic surveys were undertaken (26 June 2013). Data were instead collected for a neutral week in April 2013 (i.e. not during school holidays and on a day that no incidents were reported). Three days of data were obtained and the stage length data used in the models was that of Tuesday 23 April 2013. This was undertaken on the advice of TfL at the time of collection of the data, given that the variation between signal stage lengths along Euston Road tends to be low.

Once the stage lengths were input into the model, the model results (journey times and queue lengths) were compared against those of the queue length and journey time surveys. It was found that there were some significant differences and it was concluded that a further adjustment to the signal timings was required. This was particularly evident for the AM peak hour.

The models adjusted to match the stage length data have been provided along with this report. For clarity, these are:

- R008 2012_AM_20130522_Stage Lengths.tnd; and
- R008 2012_PM_20130522_Stage Lengths.tnd.

The stage length data obtained from TfL has been provided to support this report in the spreadsheet titled 'Region 8 – Euston Rd Stage Lengths.xlsx'.

2.7.3 Stage 2

As discussed in **Section 2.7.2**, the TRANSYT models were updated to include stage length data for 23 April 2013. However, the result showed some differences between the modelled and observed queue length data and journey times. As such, the signal times at affected junctions were manually adjusted so that the journey times and queue data was representative of the day the surveys were undertaken, so far as was reasonably practical.

2.7.3.1 Queue Validation

Table 2 provides the actual and modelled queue results. The results are presented in terms of PCUs. The observed queue results have been measured in metres and it has been assumed that one PCU equates to 5.75m. The results relate to the key junction in the vicinity of Euston station, at which traffic surveys were undertaken. For clarity, these are:

- Euston Road / Gordon Street / Melton Street;
- Euston Road / Euston Square Gardens (Bus Station Entrance/Exit);
- Euston Road / Upper Woburn Place / Euston Square;
- Eversholt Street / Grafton Place / Bus Station Entrance/Exit);
- Euston Road / Churchway / Dukes Road;
- Euston Road / Mabledon Place / Ossulston Street;
- Euston Road / Midland Road / Judd Street; and
- Euston Road / Pancras Road / Argyle Road.

Table 2: AM Peak Hour Actual vs. Modelled Queues

Node	Link	AM Peak Hour (08:00 – 09:00)		PM Peak Hour (17:00 – 18:00)	
		Model Queue (PCU)	Actual Queue (PCU)	Model Queue (PCU)	Actual Queue (PCU)
2014	1411	8	12	6	6
	1410	7	11	5	14

Node	Link	AM Peak Hour (08:00 – 09:00)		PM Peak Hour (17:00 – 18:00)	
		Model Queue (PCU)	Actual Queue (PCU)	Model Queue (PCU)	Actual Queue (PCU)
	1420	23	23	13	22
	1421	11	9	4	9
	1430	9	12	11	12
	1440	24	41	28	38
	1441	9	13	19	14
2015	1510	1	3	0	3
	1520	6	24	8	10
	1521	4	11	2	3
	1540	10	10	9	10
	1541	23	17	9	12
	1542	7	5	9	9
2020	2010	8	12	5	7
	2020	20	25	21	20
	2022	17	10	12	12
	2030	10	9	13	6
	2031	2	6	2	5
	2040	9	12	6	8
	2041	34	21	17	21
2143	14310	12	21	14	15

Node	Link	AM Peak Hour (08:00 – 09:00)		PM Peak Hour (17:00 – 18:00)	
		Model Queue (PCU)	Actual Queue (PCU)	Model Queue (PCU)	Actual Queue (PCU)
	14320	8	10	11	11
	14330	10	12	7	13
	14340	5	-	5	-
2144	14410	12	12	10	14
	14420	9	14	9	14
	14422	3	14	8	14
	14423	3	14	4	11
	14430	0	0	1	0
	14440	19	19	14	18
2064	6423	6	15	7	6
	6424	2	7	1	6
	6430	3	6	5	7
	6440	25	19	17	21
	6410	1	4	1	3
	6420	8	23	9	11
	6421	3	10	2	6
	6442	5	10	6	9
2017	1710	14	20	6	20
	1711	8	12	12	11

Node	Link	AM Peak Hour (08:00 – 09:00)		PM Peak Hour (17:00 – 18:00)	
		Model Queue (PCU)	Actual Queue (PCU)	Model Queue (PCU)	Actual Queue (PCU)
	1720	14	26	14	16
	1730	1	3	3	4
	1740	2	2	1	2
	1741	20	19	26	20
	1742	2	5	5	8
2018	1810	8	14	12	12
	1820	7	11	7	8
	1822	15	11	12	8
	1841	22	27	16	24
	1843	7	13	20	13

The comparison of the modelled and observed queue data shows that the model validates to a reasonable degree and is fit for purpose to assess the effect of the Proposed Scheme on the local highway network at this stage.

The models adjusted validated against the queue data have been provided along with this report. For clarity, these are:

- R008 2012_AM_20130522_Queues.tnd; and
- R008 2012_PM_20130522_Queues.tnd.

The queue data has previously been supplied to TfL. Details of the adjustments made to the models to achieve validation against the observed queue data is provided to support this report in the spreadsheet titled 'Validation Adjustments v1.xlsx'. The changes in green times are relative to the stage length data obtained from TfL. Adjustments have only been undertaken at junctions at which queue data is available.

2.7.3.2 Journey Time Validation

Journey times along Euston Road have been extracted from the 2012 Baseline TRANSYT model results and compared against a set of observed journey times, obtained during the traffic surveys undertaken in June 2012. Journey times from TrafficMaster were also compared with the modelled results and were found to compare more favourably with the modelled times. This is due to the fact

that the observed journey times were undertaken on one day only (not the day of the traffic counts) while the TrafficMaster data is an average over a full month. A comparison of the modelled and TrafficMaster journey times can be seen in **Tables 3** and **4** for the AM and PM peak hours respectively. It should be noted that the modelled journey times used for this comparison have been taken from the following models:

- R008 2012_AM_20130522_Queues.tnd; and
- R008 2012_PM_20130522_Queues.tnd.

Table 3: AM Peak Hour Journey Time Comparison

Direction	Segment Location	TRANSYT Link Numbers	Modelled Journey Time (s)	Observed Journey Time (s)
Eastbound	Nodes 2014 – 2020	1440, 14540, 1540, 2041	118	85
	Nodes 2020 – 2144	14440	15	27
	Nodes 2144 – 2064	6440, 6442	34	55
	Nodes 2064 – 2017	20240, 20299, 1741	48	46
	Nodes 2017 – 2018	30240, 1844, 1841	58	52
	Total		**274**	**265**
	% Difference		**3%**	
Westbound	Nodes 2018 – 2017	1822, 1824, 1720	44	47
	Nodes 2017 – 2064	6420, 6423	27	26
	Nodes 2064 – 2144	14420	43	44
	Nodes 2144 – 2015	2020	49	37
	Nodes 2015 – 2014	1520, 1420	61	94
	Total		**223**	**247**
	% Difference		**-10%**	

Table 4: PM Peak Hour Journey Time Comparison

Direction	Segment Location	TRANSYT Link Numbers	Modelled Journey Time (s)	Observed Journey Time (s)
Eastbound	Nodes 2014 – 2020	1440, 14540, 1540 (1541), 2041	118	109
	Nodes 2020 – 2144	14440	29	36
	Nodes 2144 – 2064	6440, 6442	40	67
	Nodes 2064 – 2017	20240, 20299, 1741	49	52
	Nodes 2017 – 2018	30240, 1844, 1841	49	65
	Total		**286**	**329**
	% Difference		**-13%**	
Westbound	Nodes 2018 – 2017	1822, 1824, 1720	36	51
	Nodes 2017 – 2064	6420, 6423	26	34
	Nodes 2064 – 2144	14420	44	51
	Nodes 2144 – 2015	2020	39	46
	Nodes 2015 – 2014	1520, 1420	71	45
	Total		**209**	**226**
	% Difference		**-8%**	

With the exception of the journey times along Euston Road in the eastbound direction during the PM peak hour, the journey times are comparable to the observed TrafficMaster journey times, particularly when considered over the full length of the journey time routes.

While the journey times in the eastbound direction along Euston Road during the PM peak hour differ by approximately 30%, the difference is deemed acceptable considering the level of validation achieved to the queue data. The model is therefore deemed fit for purpose for use in the assessment of the Proposed Scheme.

3 Next Steps

3.1 Introduction

The validated 2012 Baseline models are currently being taken forward to assess to effect of the Proposed Scheme when complete. This section describes the processes involved in updating the models so that the network and traffic flows are modelled appropriately.

3.2 Modelling Scenarios

The following scenarios will be modelled for both the AM and PM peak hours:

- 2026 Future Baseline
- 2026 With Scheme
- 2041 Future Baseline
- 2041 With Scheme

The Future Baseline scenarios will account for any changes to the network layout as well as growth in traffic flows since the 2012 baseline scenario. The traffic flows will account for any committed developments in the area but also considers any reduction in traffic flows associated with the removal of the Euston station basement car park and other losses of on-street car parking.

The With Scheme scenarios account for any change to the layout of the network associated with the Proposed Scheme as well as any changes to the volume and distribution of traffic flows as a result of the scheme.

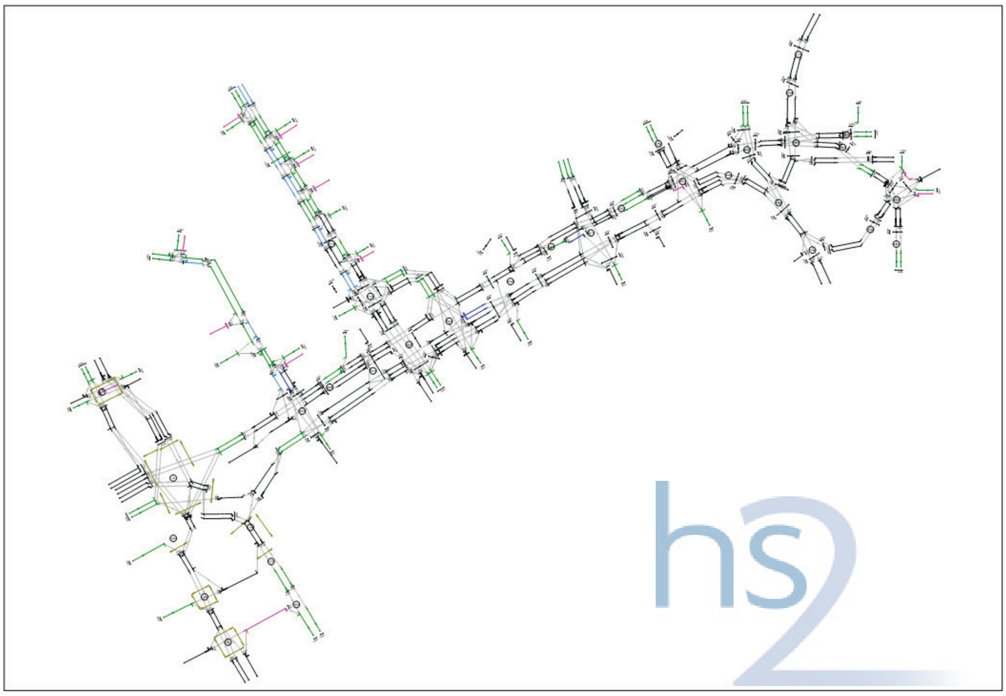
3.3 Model Scope

For all future scenarios, the scope of the TRANSYT model has been updated to include TfL's Euston Circus (junction of Euston Road with Hampstead Road and Tottenham Court Road) TRANSYT model. This also includes the junction of:

- Euston Road with Gower Street;
- Gower Street with Grafton Way;
- Gower Street with University Street;
- Tottenham Court Road with University Street and Maple Street;
- Tottenham Court Road with Grafton Way;
- Tottenham Court Road with Warren Street; and
- Hampstead Road with Drummond Street.

The full scope of the model can be seen in **Figure 4**.

Figure 4: Extended Euston Road TRANSYT Model



It is acknowledged that Euston Circus does not form part of Region 8 (it is part of Region 9) in terms of the traffic signal control and that the junction, in its previous layout, operated at a different cycle time. However, the Euston Circus TRANSYT model provided by TfL does not include the full Region 9 area. The model that has been provided by TfL runs at a cycle time of 96s seconds, similar to the Euston Road Region 8 model.

Given the importance of Euston Circus in terms of the Proposed Scheme and the likely increases in traffic flows in the 2026 and 2041 with HS2 scenarios, combining the models, acknowledging that future cycle times are unknown, is deemed appropriate in order to robustly model the impact of the Proposed Scheme on both Euston Circus and the Euston Road corridor.

3.4 Traffic Flows

For all 2026 and 2041 scenarios, the traffic flows will be derived by calculating the absolute difference between the 2012 Baseline and future scenario, Central London Highway Assignment Model (CLoHAM), developed using SATURN, and adding this to the 2012 Baseline traffic survey flows. For example, for the 2026 Future Baseline model, the traffic will be calculated using the following formula:

$$(2026\ Future\ Baseline\ CLoHAM\ Traffic\ Flows - 2012\ Baseline\ CLoHAM\ Traffic\ Flows) + (2012\ Traffic\ Survey\ Flows)$$

It should be noted, however, that the traffic flows will be checked prior to use in the future models to ensure that any spurious flows are eradicated and a more sensible flow will be derived. This process will be fully documented.

It is also worth noting that all traffic flows at junctions east of Pancras Road will be input directly from the CLoHAM output traffic flows as not survey data is available. Again, these flows will be checked prior to their use in the model to ensure that all the movements at each of the junctions are sensible.

Annex C(v) – Old Oak Common TRANSYT Model Performance Technical Note

This annex contains the Old Oak Common local area TRANSYT model technical note which explains the aims, methodology, data sources, analysis, results and recommendations for the TRANSYT modelling of local junctions in the Old Oak Common (OOC) area in London as part of the Proposed Scheme.

Technical Note

Subject	C221 HS2 Old Oak Common Local area TRANSYT model		
Date	20/09/13		
Doc ref no.	C221-MMD-TM-NOT-010-600005	**Revision:** P01	**Status:** FOR INFORMATION ONLY

Authors	[redacted]
Copy	[redacted]
[redacted]	[redacted]

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1 Executive Summary

1.1 Overview

1.1.1 This Technical note explains the aims, methodology, data sources, analysis, results and recommendations for the TRANSYT modelling of local junctions in the Old Oak Common (OOC) area in London as part of the HS2 scheme.

1.1.2 The report forms a supporting document to the Hs2 Transport Assessment which itself supports the Hs2 Environmental Assessment to be submitted as part of the Hs2 Hybrid Bill documentation.

1.1.3 As well as informing the Interim Preliminary design, the local TRANSYT models provide information to enable refinement and optimisation of the WELHAM models used in the Environmental Assessment and will subsequently be used Post hybrid Bill to examine and optimise detailed signal timings for construction phases as part of the Hs2 construction traffic management strategy.

1.1.4 For data handling and presentation purposes the OOC TRANSYT model covers an area containing three groups of junctions, namely;

- A40/Wells Farm Road/Gypsy Corner
- A40/OOC lane/Savoy Circus and
- the OOC lane/Victoria Road junction and extending to the new OOC station junctions

1.1.5 As these three groups of junctions, or traffic signal regions, may operate on different signal cycles, if required to optimise each group, it will be necessary to separately run the TRANSYT models optimisation procedure for each. However, the development of a combined modelled area enables data consistency checks to be efficiently and readily presented. This process has been very successfully applied on Crossrail and other major projects.

1.1.6 All the data used and output from the TRANSYT model process can be used for subsequent more detailed micro-simulation modelling (e.g. VISSIM) where required.

1.2 Background

1.2.1 The objective of the supporting HS2 transport assessment at this stage is to assist in defining the land take required in terms of highway infrastructure for both the permanent and construction works and the Environmental effects of the scheme both during construction and for the operation of the scheme.

1.2.2 In order to meet the objectives of the Mayor's Transport Strategy the scheme is required to provide a sustainable transport strategy that enables the highway authority (eg TfL or local boroughs) to maintain acceptable flow to meet its obligations under the Traffic Management Act.

1.2.3 Whilst the Hs2 scheme will provide a major new transport hub and a potential catalyst to regeneration in the OOC area it is required to identify the effects of the scheme by all modes and mitigate the impact of the scheme as appropriate.

1.2.4 As an overview, the modelling framework for HS2 is shown in Figure 1 below and can be summarised as:

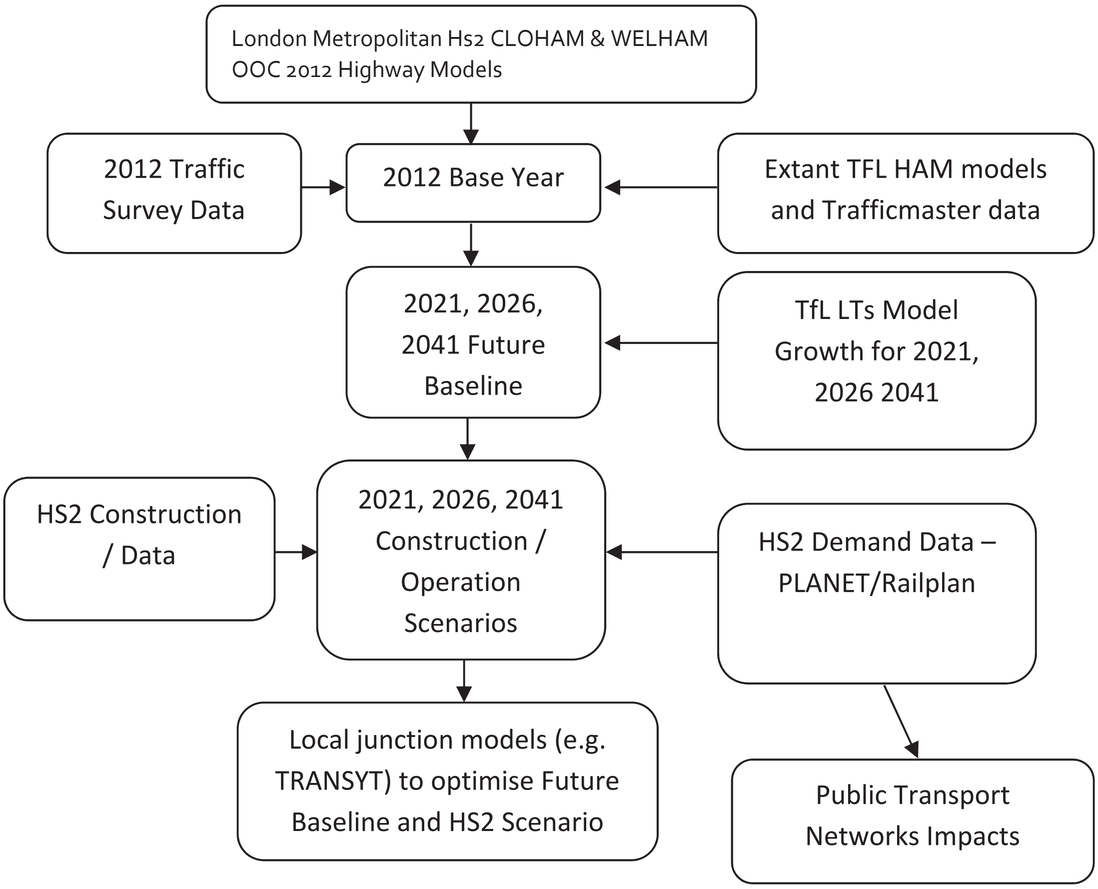
- Strategic long distance rail demand modelling - the PLANET Framework of Models (PLANET Long Distance);
- Regional Multi Modal Transport Modelling - the TfL London Transport Studies (LTS) model
- Strategic highway assignment modelling – The TfL Central London Highway Assignment Model (CLoHAM) and West London Highway Assignment Model (WeLHAM)
- Regional rail modelling – The TfL Railplan model
- Local junction modelling as required

1.2.5 Construction is planned over the period 2017-2026 with Hs2 phase 1 operation in 2026, and phase 2 operation including extension of the scheme to Manchester by 2041. By identifying works required to mitigate the effects of the operational scheme (2041), it may be appropriate to implement elements of these at an earlier stage to partially mitigate the effects of construction of surface access modes in and around the OOC area.

1.2.6 The purpose of the modelling work was thus to ensure that the effects of construction and operation were fully assessed, to include the following:

- Support the assessment by providing traffic data to inform Air Quality and Sound impacts together with community severance; and
- Inform the engineering design of HS2 for both the construction and operational phases of the project.

Figure 1: London Metropolitan Area Modelling Framework



1.3 Methodology

1.3.1 The methodology for the assessment follows best practice guidelines and includes:

- DfT guidelines for transport assessment
- TfL Transport Assessment Best Practice April 2010
- TfL Model Auditing Process

1.3.2 Information from the WELHAM strategic model of the area, surveys, Trafficmaster information and models provided by TfL were used to produce a local area TRANSYT baseline model for 2012.

1.3.3 The model was calibrated comparing the flows with surveyed flows, strategic model data and the journey time information from Traffic master.

1.3.4 The impact of the proposed development through the Community Forum Area (CFA) 4 area has been appraised through a combination of strategic and local modelling exercises.

1.4 Results

Operational

1.4.1 The close correlation between the observed and TRANSYT journey times and traffic volumes between the main corridors of the area of influence showed that the base model was robust and was suitable for use in optimising the WELHAM model and potential future use in more detailed assessment of junction operation.

1.4.2 Over the wider area, the increase in flow due to the Hs2 operational scheme had negligible effect on the junction between A40 and OOC Lane and at A40 and Wales Farm Road.

1.4.3 The proposed modifications at the junction between Victoria Road and Old Oak Common Lane improve the capacity at this junction. This allows it to cater for increases in flow of general traffic and buses due to the development.

Construction

1.4.4 At this stage examination for the Hs2 construction intervention (of more than 5 years) have been examined at a strategic level using WeLHAM-Hs2. Whilst the effect of additional construction vehicles in the network has a limited effect, the full closure of OOC for up to 8 months for road lowering to allow double deck buses will need to be considered further in liaison with TfL.

1.5 Further work

1.5.1 The results are based on 2012 and 2041 forecast AM and PM peak flows and hence may need to be further calibrated for any change in flows from the strategic forecast models to consider wider area diversion effects arising during individual construction phases.

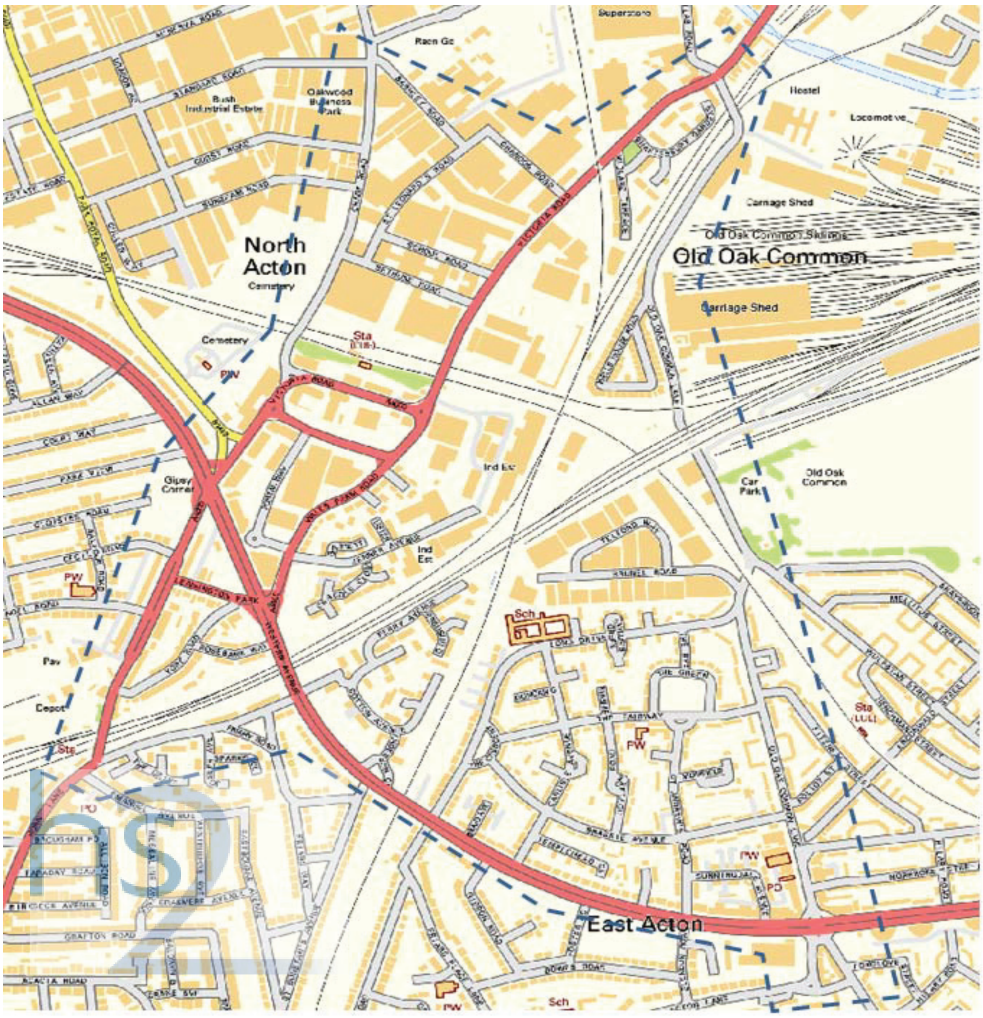
1.5.2 Further iterations and re-optimisation of signal timings in the strategic model would be considered in more depth at the detailed design stage. At this stage the strategic models are used to provide a forecast model base on which to assess the incremental effect of the OOC operational traffic. As explained, the OOC TRANSYT model contains signal regions running on different signal cycles. These would need to be separately optimised when using the model for closer examination of specific signal regions at the detailed design stage.

2 Introduction

2.1 Overview

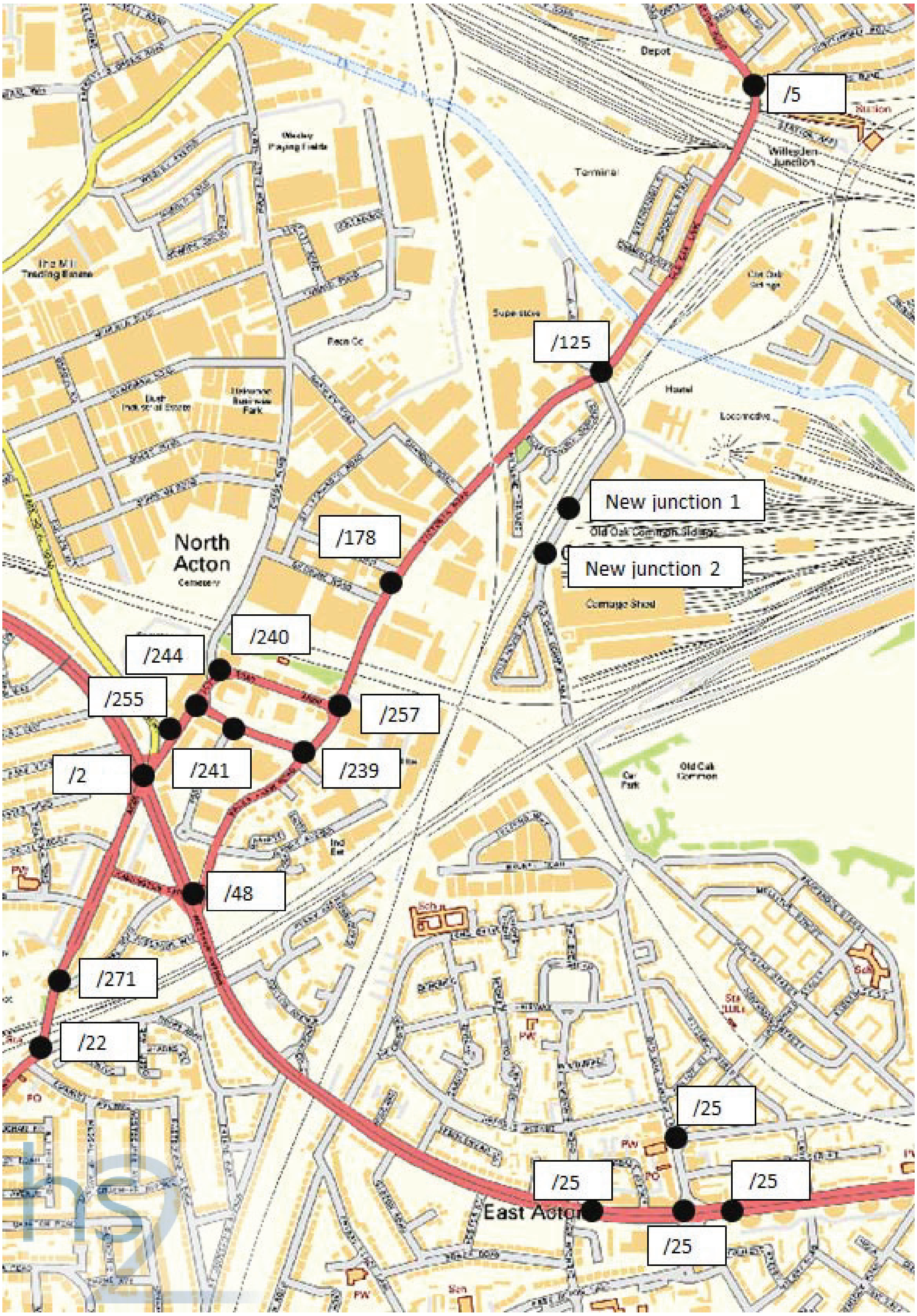
2.1.1 The area of influence within the London Metropolitan section is largely defined by the highway interventions required for construction, other than at OOC where there will be some permanent infrastructure affecting highway movements. Two signalised junctions to access the station at OOC Lane and improvements at the junctions between Victoria Road and OOC Lane have been proposed to cater for the development flow generated (Refer Figures B1 and B2 in Appendix B for details). This assessment of the local network details the effects of the traffic generated due to the development around the Old Oak Common (OOC) highway network as predicted by the software programme TRANSYT. The main area of influence for the Old Oak common Lane improvement, obtained from the WeLHAM-Hs2 strategic modelling run, and the affected signal sites are shown in Figures 2 and 3.

Figure 2: Main area of influence around Old Oak Common Lane



Source: Mott MacDonald

Figure 3: Affected signal sites (Including TfL Junction references)



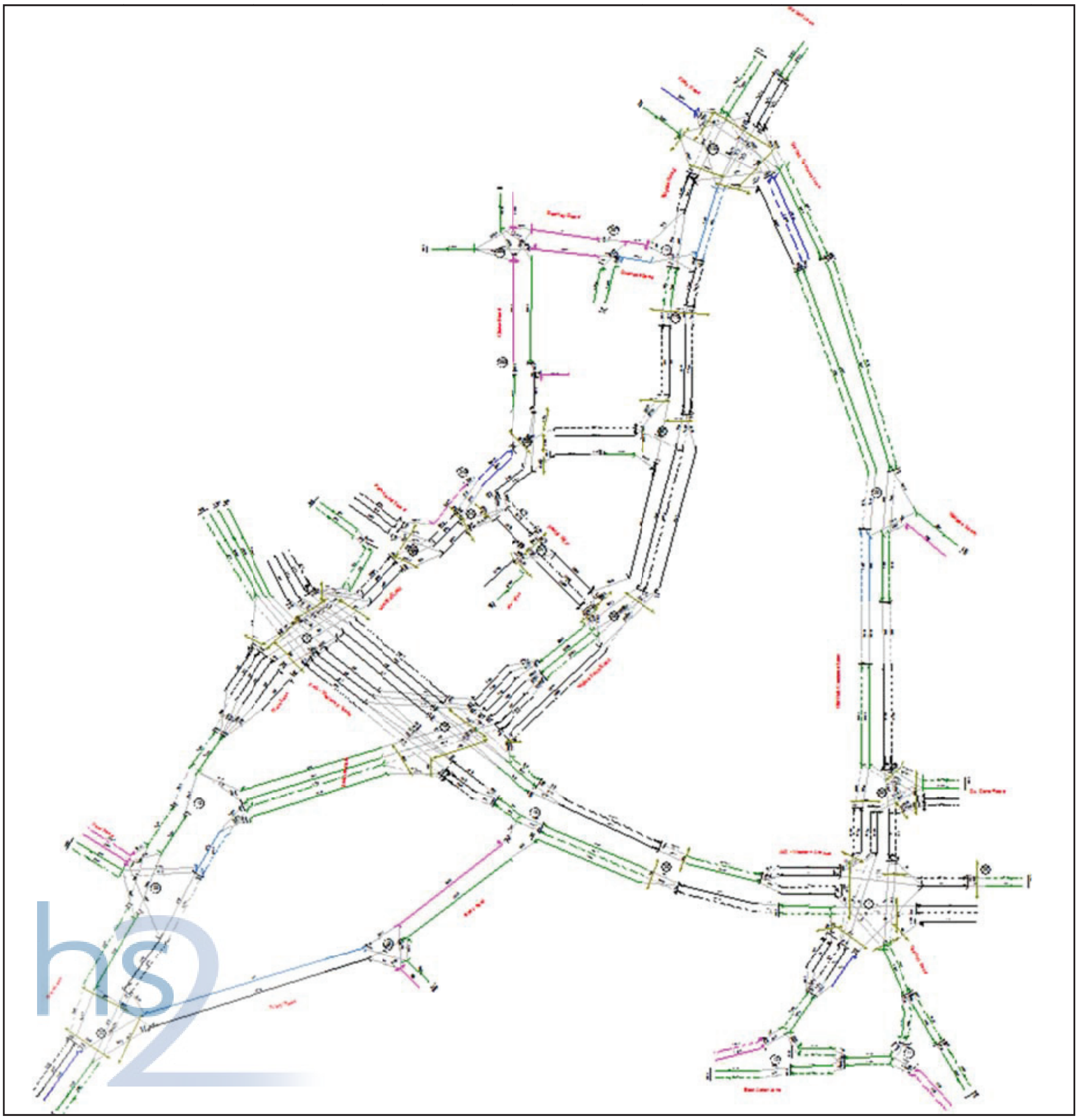
Source: Mott MacDonald

3 Base Model

3.1 Area of TRANSYT models

3.1.1 The OOC TRANSYT model was built covering the area of influence (derived from the strategic model) shown in Figure 4.

Figure 4: Old Oak Common Lane TRANSYT Network



(Source: Mott MacDonald - Zone 5_Old Oak Common_Base 2012_AM_V3.tnd)

3.2 Baseline network

3.2.1 The OOC TRANSYT model was developed combining two separate models[1] received from TfL (dated 2007). These models were the most recent available and provided a starting point for the development of the OOC Lane TRANSYT baseline model.

3.2.2 Network information has been obtained from OS mapping, aerial mapping and initial network observations. These are shown in Appendix A.

3.2.3 The Old Oak Common Lane base year 2012 TRANSYT model network includes the junctions listed in Tables 1 and 2 below and illustrated in Figure 2:

Table 1: TRANSYT base model – Junctions covered by TfL Model

Node Number	Junctions	Junction Type
264	Du Cane Road / Old Oak Common Lane	Signalised
1	A40/ Old Oak Common Lane	Signalised
99	A40 Pedestrian crossing east of A40/Old Oak Common Lane	Signalised
48	A40/ Wales Farm Road/ A4000	Signalised
2	A 4000 Horn Lane/ A40/ Victoria Road	Signalised
255	Park Royal Road/ Victoria Road	Signalised
241	Victoria Road/ Portal Way	Signalised
239	Wales Farm Road/ A4000	Signalised
240	Victoria Road/ A4000	Signalised
243	Victoria Road/ A4000	Priority
256	Victoria Road/ Chase Road	Signalised
257	Victoria Road/ Wales Farm Road	Signalised

3.2.4 In the base model additional junction nodes as listed in Table 2 were added to extend the base model obtained from TfL without making any changes to existing nodes and links (except link lengths at extension points).

Table 2: TRANSYT base model – Junctions added to represent the OOC Lane TRANSYT network

Node Number	Junctions	Junction Type
125	Victoria Rd/ Atlas Rd/ Old Oak Lane	Signalised
29	Old Oak Common Lane/ Wulfstan Street	Priority
11	East Acton Lane/ Old Oak Road	Priority
12	East Acton Lane/ Old Oak Common Lane	Priority
25	A40 Pedestrian crossing west of A40/Old Oak Common Lane	Signalised
16	A40/ Friary Road	Priority
18	Friary Road	Priority
22	Friary Road/ A 4000 Horn Lane	Signalised
23	A 4000 Horn Lane/ Noel Road	Priority
15	A 4000 Horn Lane/ A4000	Priority
268	Chase Road/ Bethune Road	Priority
178	Pedestrian Crossing Victoria Road	Signalised
14	Victoria Road/ Chandos Road	Priority
269	Chase Road/ Standard Road/ Bashley Road	Priority
270	Bashley Road/ St Leonard's Road	Priority
271	Horn Lane pedestrian crossing	Signalised

[1] R129 2007_AM_B_1.tnd and R429 2007 AM_B_1.tnd for AM model and R129 2007_PM_B_1.tnd and R429 2007 PM_B_1.tnd for PM model

3.3 Baseline signal control data

3.3.1 The signal control data for the TRANSYT models received were verified using the signal timings in the SATURN WeLHAM model[2] received from TfL (2009 flows). The signal control data for junctions added to the TRANSYT base models have been derived from the same SATURN model, and checked against short term observations on site.

3.4 Baseline saturation flows

3.4.1 The saturation flows for the TRANSYT models received from TfL were not modified except for TRANSYT nodes 2, 48 and the nodes around Victoria Road gyratory along with TRANSYT node 125, which were measured as detailed in Appendix D including site observations in July 2013. These measurements were carried out for calibration of the base model.

3.5 Base model flows and journey times

3.5.1 Baseline traffic flows have also been derived from the SATURN WeLHAM Hs2 model[3]. "Demand flows" have been used in the TRANSYT models at this stage (recognising that they are marginally higher than 'actual flows'). Demand flows are those flows that would travel through the network if there were no or only limited upstream bottlenecks. The focus of this assessment has been on determining the incremental effect of HS2 on the Old Oak Common Lane area. Flow conversion from SATURN to TRANSYT on major links is detailed in Table C1 and C2in Appendix C. The GEH value for the flows entered in the TRANSYT links compared to the observed (Surveyed between 06/10/2012 and 10/10/2012) flows where available were mostly below 5. Flow comparison for the junction between Old Oak common Lane and Victoria Road where the impact is likely to be severest is also below 5 as detailed in Table 3.

3.5.2 The programme of surveys as set out in the London Metropolitan Traffic survey report (Dec 2012/March 2013), was based on maximising use of existing TfL TRANSYT model data, and thus excluded some base flows for the movements at the A40 junctions as these form part of the TRANSYT models. It was also necessary to avoid the effect of temporary road closures at the Hammersmith flyover in late Spring 2013. Hence, flows were collected on only a limited number of links in the area, with existing model data being used wherever possible

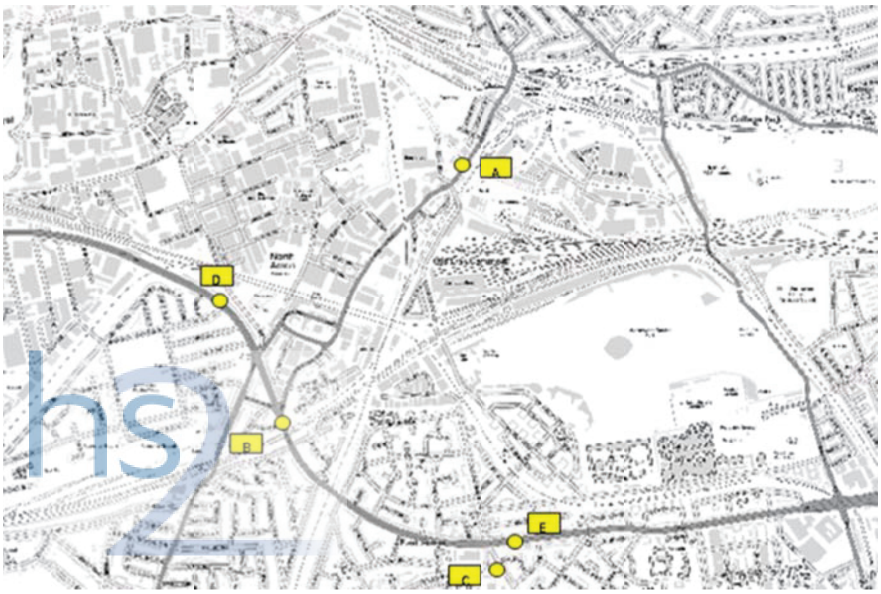
[2] AM model ref: W1_B09_02b_A_MML_HS2_OOC_NE1_b.UFS and PM model ref: W1_B09_02b_P_MML_HS2_OOC_NE1_b.UFS
[3] Refer 'Zone 5 Old Oak Common Saturn Data for TRANSYT AM.doc' and 'Zone 5 Old Oak Common Saturn Data for TRANSYT PM.doc'

Table 3: Flow conversion from SATURN to TRANSYT (AM Peak) compared to surveyed flows (Victoria Rd/ Atlas Rd/ Old Oak Ln)

			Observed	SATURN		TRANSYT		
SATURN Nodes			Oct-12	2012 (Base)	GEH		2012 (Base)	GEH
A Node	B Node	C Node	Flows (PCU)	Flows (PCU)		Link	Flows (PCU)	
Victoria Rd/ Atlas Rd/ Old Oak Common Lane								
65091	64129	64942	15	37	4.31	12510	37	4.31
65091	64129	64395	382	437	2.72	12510	331	2.72
						12512	106	
65091	64129	64998	219	233	0.93	12512	233	0.93
64998	64129	64395	98	96	0.20	12522	96	0.20
64998	64129	64942	12	21	2.22	12520	21	3.51
64998	64129	65091	137	174	2.97	12520	174	
64395	64129	64942	22	23	0.21	12531	23	
64395	64129	65091	271	335	3.68	12531	335	
64395	64129	64998	176	87	7.76	12531	87	1.12
64942	64129	65091	13	16	0.79	12540		
64942	64129	64998	7	16	2.65	12540	32	2.35
64942	64129	64395	20	17	0.70	12541	20	0.00

3.5.3 Modelled journey times(4) for the AM peak, as shown in Table 4 for the timing points shown in Figure 5were compared with observed journey times extracted from Trafficmaster to calibrate and validate the base model. The timing points compare journey times along the main routes through the main area of influence. Comparison of modelled and observed journey times show comparable results with differences in journey times within +/- 15%. SATURN journey times are also shown in Table 4.

Figure 5: Old Oak Common journey time timing points



[4] Refer WP_224c OOC TRANSYT Journey times.xls

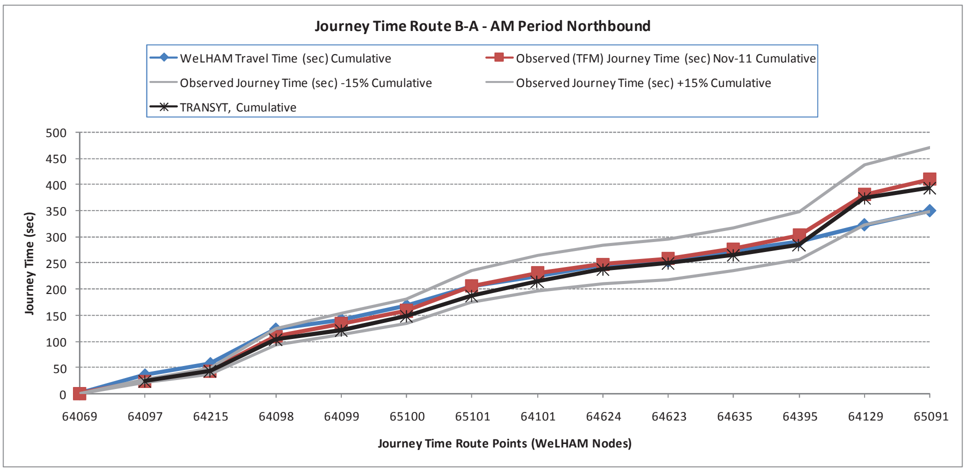
Table 4: Old Oak Common journey times comparison (2012 Base AM)

		AM 2012						
Transit points	Direction	Traffic Master Journey Time (sec) Nov 2012	SATURN			TRANSYT		
			Journey Time (sec)	Difference (sec)	% Difference wrt Traffic Master	Journey Time (sec)	Difference (sec)	% Difference wrt Traffic Master
A - B	SB	377	260	117	31	339	38	10
B - A	NB	409	349	60	15	393	16	4
A - C	SB	424	417	7	2	446	-22	-5
C - A	NB	345	369	-24	-7	392	-47	-14
A – D	SB	381	296	85	22	342	39	10
D –A	NB	313	226	87	28	291	22	7
D - E	WB	259	286	-27	-10	227	32	12
E - D	EB	123	174	-51	-41	128	-5	-4
Overall		2631	2377			2558		

Note: Traffic Master and Saturn Journey time from: OOC WeLHAM Model 2013 Journey time – For TRANSYT V2.xlsx
TRANSYT journey time from: WP_224c OOC TRANSYT Journey times.xls

3.5.4 The comparison of observed and modelled journey times for each route are shown in figures in Appendix E. Figure 6 shows the correlation along Old Oak Common Lane in the northbound direction in the AM peak where HS2 effects are likely to be greatest. As indicated in the figures in Appendix E the journey times are comparable for all routes. Given that the base model was built from models provided by TfL, and journey time modelling is as good as it is, the AM base model was deduced to accurately represent traffic operations.

Figure 6: Journey time comparisons along route B-A (sample)



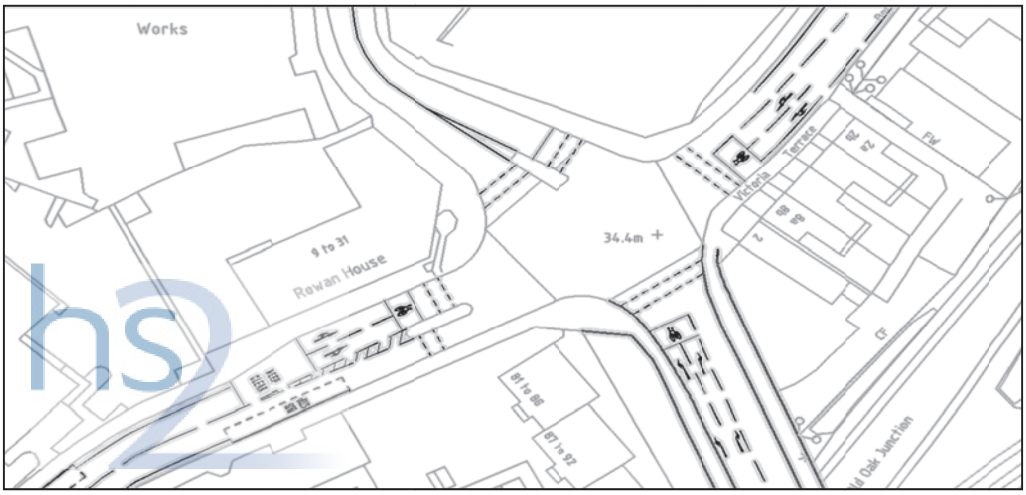
3.5.5 Comparisons of modelled and observed journey times for the PM peak for the same routes and timing points are detailed in Appendix E. Journey times are again within +/- 15%. Except route A-C C-A is above 15% validation. Links where blocking causes high delays are not easily replicated by the model. This explains the higher differences in journey times.

3.6 Base model queues and degrees of saturation

AM Peak

3.6.1 The existing layout for the junction between Old Oak Common Lane and Victoria Road where HS2 effects are likely to be greatest is shown in Figure 7.

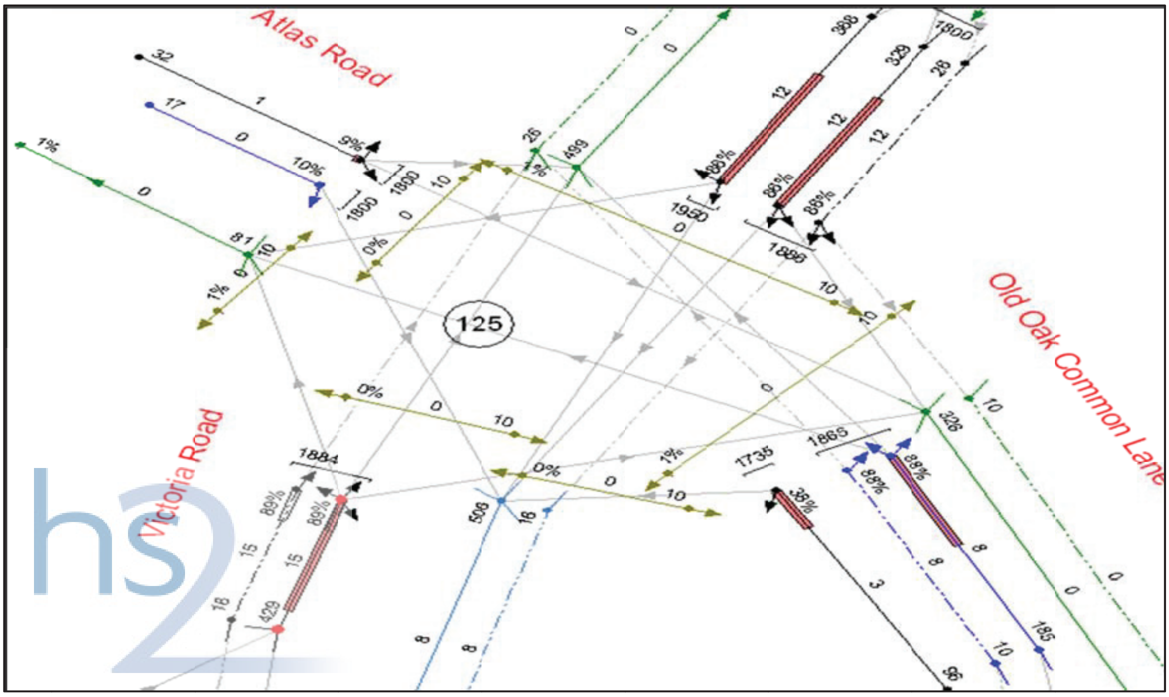
Figure 7: Existing road markings at the junction between OOC Lane and Victoria Road



Source: OCC Cad drawing

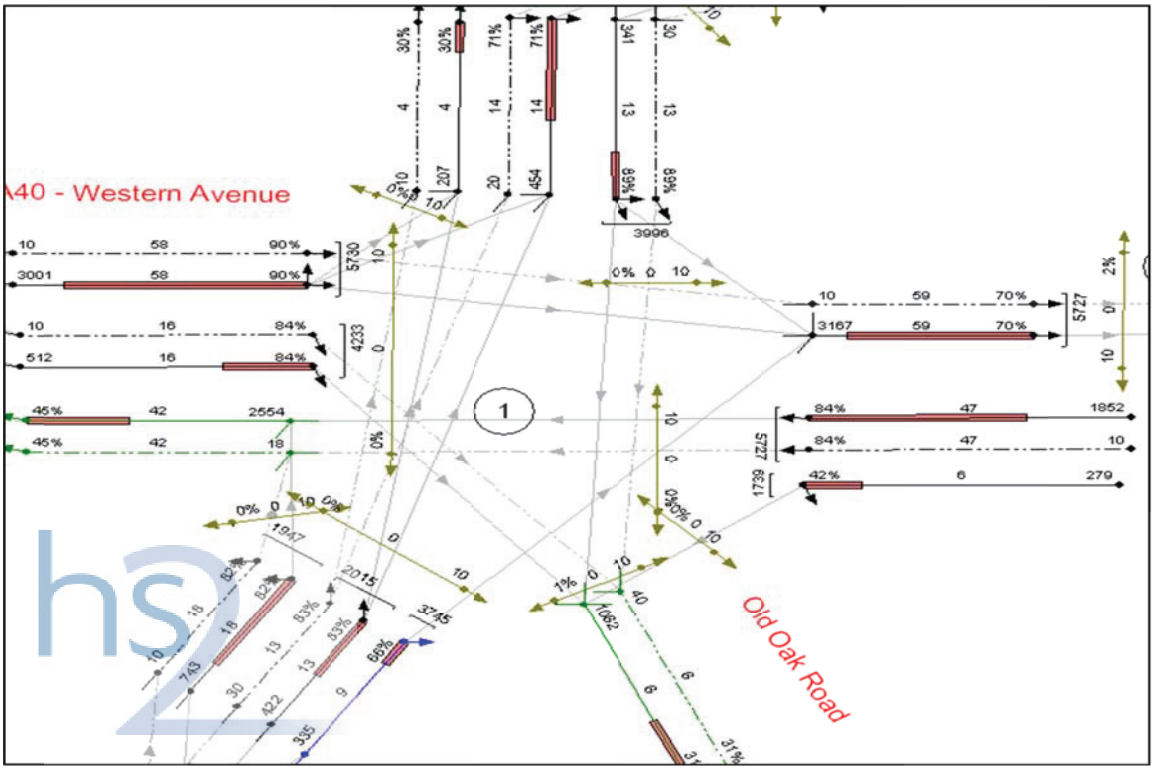
3.6.2 Modelling results showed the network operating generally within capacity for the AM peak. The junction between Old Oak Common Lane and Victoria Road (Refer Figure 8) and the junctions along the A40 and have little or no spare capacity (Refer Figures 9 and 10), which is a good reflection of the ground situation. (Source: Mott MacDonald - Zone 5_Old Oak Common_Base 2012_AM_V3.tnd).

Figure 8: Base 2012 AM TRANSYT Model: ***Node 125 (Old Oak Common Lane / Victoria Road)***



Note: Display on links - (Degree of Saturation - Mean Max queue - Flow in PCU)

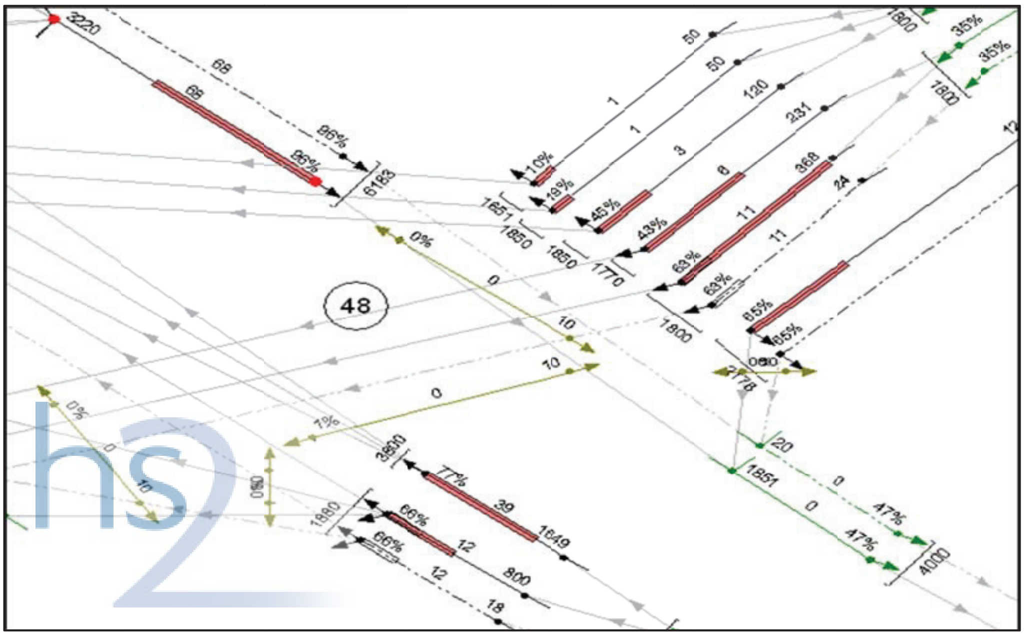
Figure 9 Base 2012 AM TRANSYT Model: ***Node 1 (A40 / Old Oak Common Lane)***



Note: Display on links - (Degree of Saturation - Mean Max queue - Flow in PCU)

3.6.3 However due to the high volume of eastbound traffic on A40, the DoS was 96% on the A40 eastbound links (Refer Figure 10). The model is based on the demand flow at the junctions and is showing the prevailing situation where queues build up on these links.

Figure 10: Base 2012 AM TRANSYT Model: *Node 48 (A40 / Wales Farm Road)*

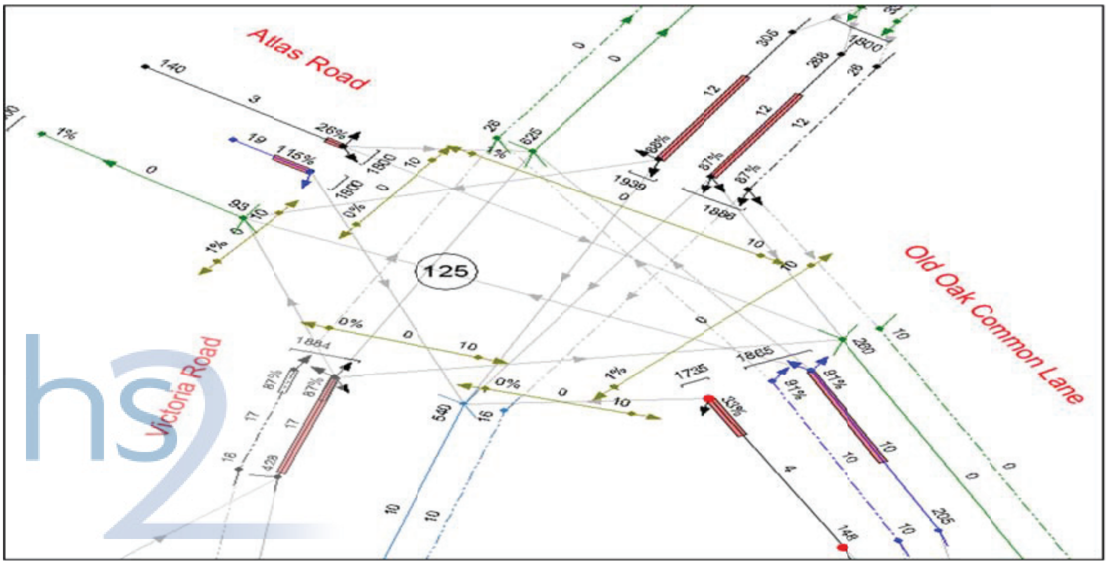


Note: Display on links - (Degree of Saturation - Mean Max queue - Flow in PCU)

PM Peak

3.6.4 Modelling results showed the network operating within capacity (Refer Figures 11 and 13), except at the junction between the A40 and OOC Lane (Refer Figure 12). (Source: Mott MacDonald - Zone 5_Old Oak Common_Base 2012_PM_V3.tnd).

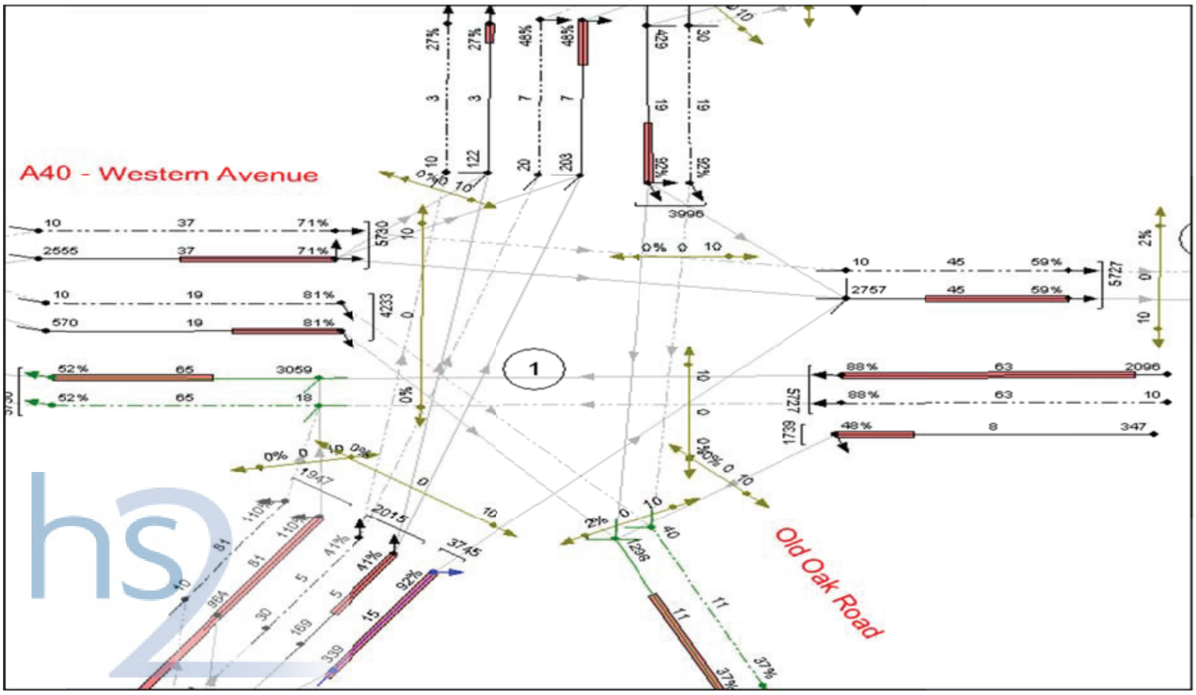
Figure 11: Base 2012 PM TRANSYT Model: ***Node 125 (Old Oak Common / Victoria Road)***



Note: Display on links - (Degree of Saturation - Mean Max queue - Flow in PCU)

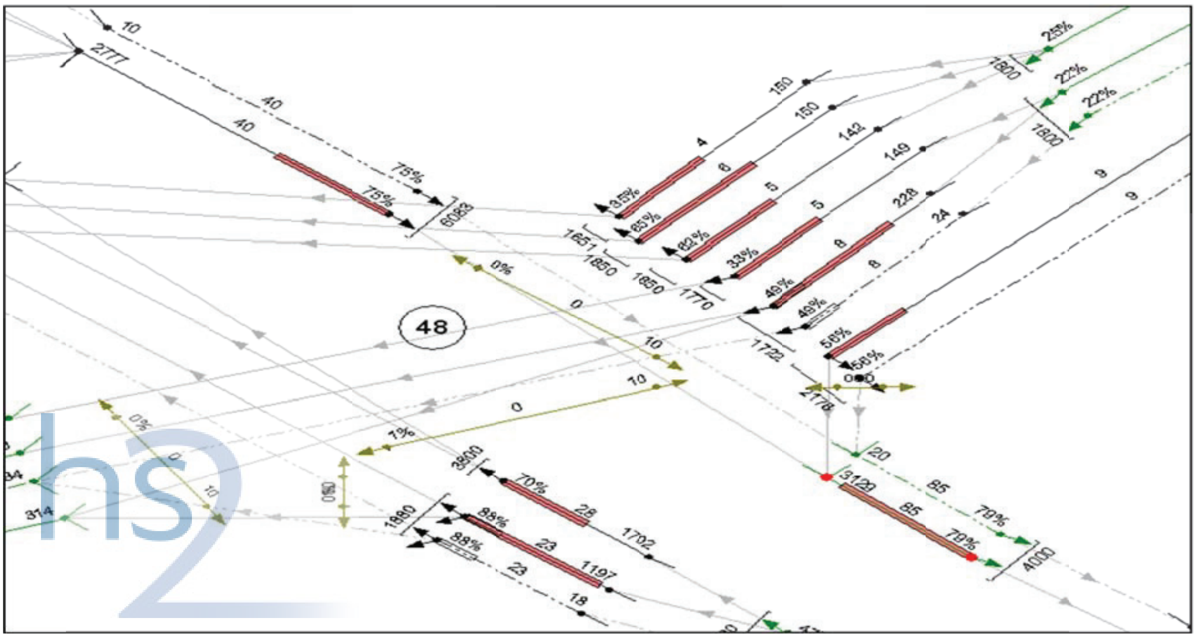
3.6.5 The DoS was 110% and 92% on the northbound and southbound links on the Old Oak Common Lane A40 approaches (Refer Figure 12). There is only one lane catering to the left turn traffic and a demand flow of 974 pcu/hr on this link is very high.

Figure 12: Base 2012 PM TRANSYT Model: ***Node 1 (A40 / Victoria Road)***



Note: Display on links - (Degree of Saturation - Mean Max queue - Flow in PCU)

Figure 13: Base 2012 PM TRANSYT Model: ***Node 48 (A40 / Wales Farm Road)***



Note: Display on links - (Degree of Saturation - Mean Max queue - Flow in PCU)

4 TRANSYT model with proposed junctions

4.1 Proposed junctions

4.1.1 TRANSYT models[5] for both AM and PM peaks were built incorporating the proposed junctions (Node 265 and 267 - refer drawing 'Old Oak Common Proposed Road markings') for access to and from the OOC site as shown in Figures B1 and B2 in Appendix B. The model also incorporated the improvements proposed at the junction between OOC Lane and Victoria Road and along Victoria Road (refer drawing 'Old Oak Common Proposed Road markings').

4.2 Forecast traffic flows

4.2.1 Forecast traffic flows were derived from WeLHAM models[6] for 2021 (construction phase), 2026 (Hs2 – Phase 1) and 2041 (Hs2 Phase 2). "Demand flows" have been used from the WeLHAM model in the TRANSYT models. The focus of this assessment has been on determining the incremental effect of HS2 on the Old Oak Common Lane area.

4.3 Development trip generation and distribution

4.3.1 Applying the modal split based on the modal share analysis (Refer wp_146_k) to the OOC 2-way front door flow results in nearly 300 vehicles being generated in addition to the background traffic – 200 vehicles inbound and 100 vehicles outbound. The development traffic flows were reversed as a proxy for the PM peak period assessment, i.e. with 200 vehicles outbound and 100 vehicles inbound. In practice it would be expected that eastbound traffic to the site from the A40 could be signed to exit the A40 via the left turn at the A40/Old Oak Common (OOC) Lane junction and on leaving the site would be directed north to the OOC Lane/Victoria Road junction to turn left down Victoria Road to re-join the A40 at the Gypsy Corner junction.

4.3.2 Based on the 2012 trip distribution derived from the WeLHAM Hs2 model, the development flow is broadly distributed 60:20:20 to the west: south & east: north respectively. This is based on East Acton Zone in the WeLHAM Model and is the preferred option as it represents a 'credible worst case scenario' as illustrated in Table 5 (Option 1A).

4.3.3 An increase in bus flows to 34 each way from the present 13 buses has also been assumed due to the improvements to the bridges on the section north of Wulfstan Road on Old Oak Common Lane.

[5] Zone 5_Old Oak Common_Base 2012_AM_Proposedbase1AV3.tnd and Zone 5_Old Oak Common_Base 2012_PM_Proposedbase1AV3.tnd
[6] Refer WP_224c OOC TRANSYT Journey times.xls for the models used

4.4 Increase in flow at key locations

4.4.1 The change in flows during the AM peak period at key locations (refer Figure 14) was compared as shown in Figure 15 to illustrate the change in flow on key links, A40, Victoria Road and Old Oak Common Lane (OOC Lane).

4.4.2 The graphics show that the increase in flow on OOC Lane is lower compared to other locations. The flow in OOC Lane in 2026 (Hs2 Phase 1) is lower compared to 2012. This is probably due to increases in bus flows on OOC Lane.

Figure 14: Old Oak Common flow measurement Points

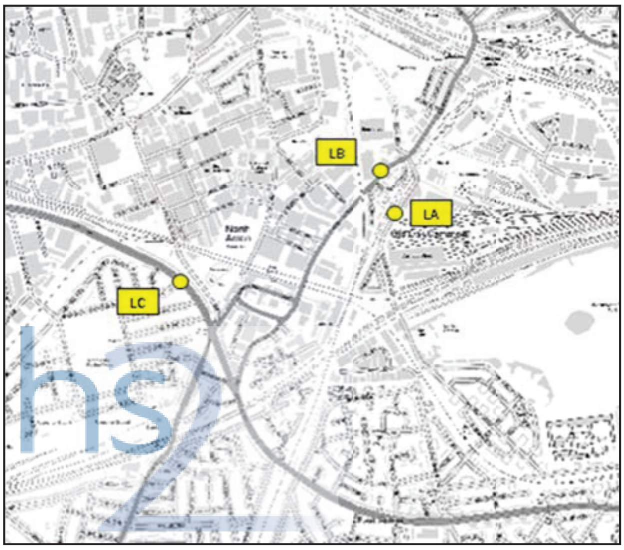
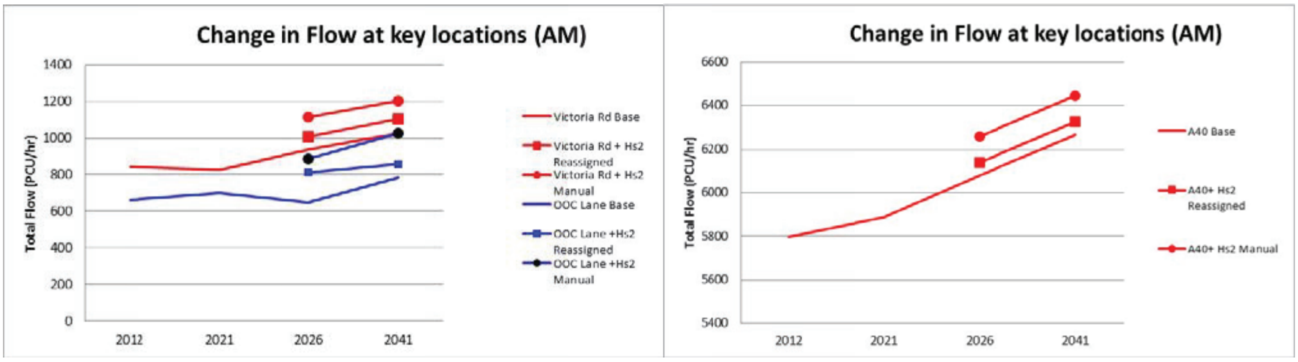


Figure 15: Change in flow (Victoria Road and Old Oak Common Lane)



Source: WP_224c OOC TRANSYT Journey times.xls

4.4.3 The reassigned flows (Base + development) from the SATURN model on all links are lower compared to base flow + manually added flow distributed as detailed in section 4.5. OOC station development trips have therefore been manually superimposed on the base traffic levels without making any allowance for reassignment of background traffic over the wider area. This was done in order to provide a worse case of the assessment of the potential impact of hs2 development traffic for purpose of land take / highway requirements and the associated environmental statement. In other words the worst case scenario is the 2041 base flow + manually added development flow.

4.4.4 Change in flow over time during PM peak period is illustrated in Figures F1 and F2 in Appendix F.

4.5 Options Tested

4.5.1 2012 base flows with development worst case turning flows manually added were tested to show that the network can function within capacity with the proposed modifications. Flows manually added to 2012 model are shown in Table 5 below.

4.5.2 2041 flows with development flows derived from RAILPLAN model manually added were tested. Development flow distribution is shown in Table 6.

4.6 2012 Options

Option 1A

4.6.1 In this option junction improvement at node 125 (Victoria Rd/ Old Oak common) were assumed as shown in Figure 16 with worst case scenario of 300 trips as detailed in Table 5.

Table 5: Flow distribution

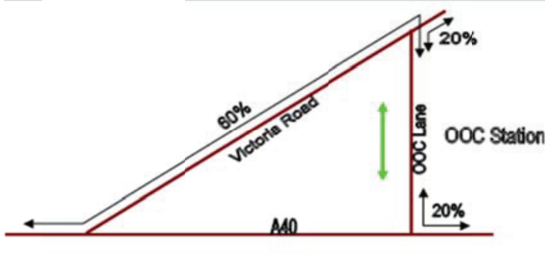
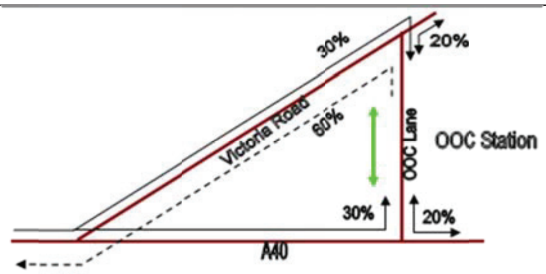
Option	Trips generated (pcu)	Distribution	Base Flow (2012 AM) (clockwise from Victoria Rd)	Additional Flow	Total (2012 + Development)
1A	300		Inbound: 87:223:422 Outbound: 96:164:70	Inbound: 120:40:40 Outbound: 60:20:20	Inbound: 207:263:462 Outbound: 156:184:90 34 buses along OOC Lane
1B	300 (Preferred option)		Inbound: 87:223:422:239 Outbound: 96:164:70	Inbound: 60:40:40:6 0 Outbound: 60:20:20	Inbound: 147:263:462:29 9 Outbound: 156:184:90 34 buses along OOC Lane

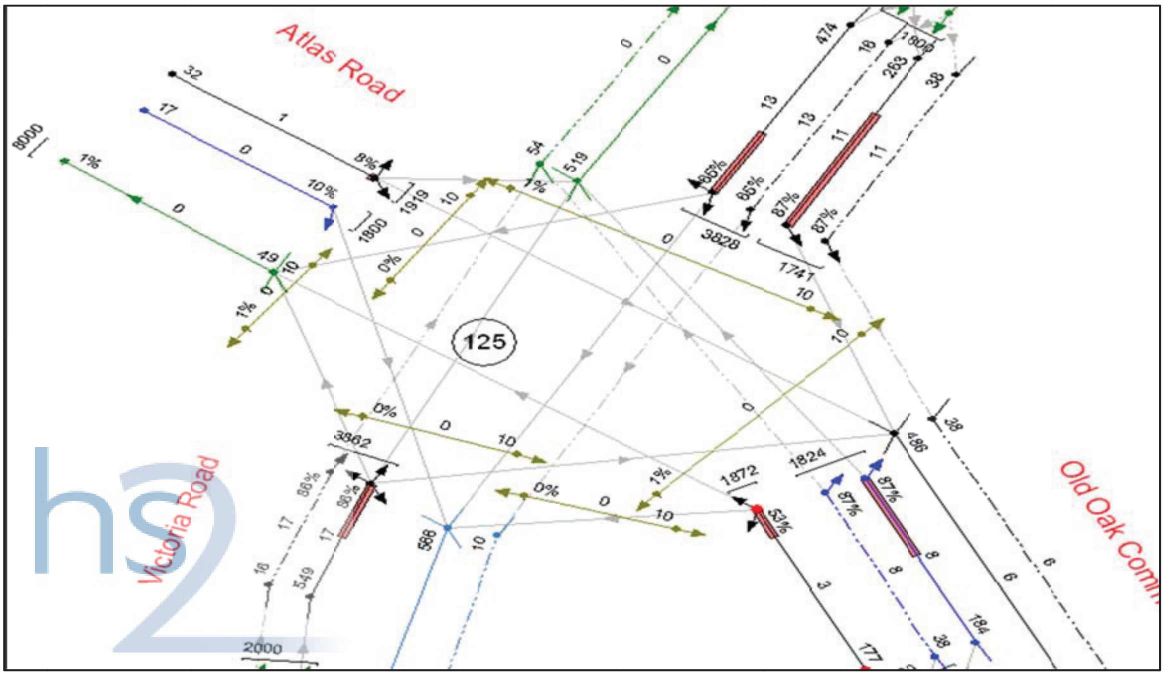
Figure 16: Option 1 – Layout of Node 125

Source: old Oak Common Proposed Road markingsA1.dwg

4.6.2 Results from the TRANSYT models[7] show that the most likely junctions affected by this increase in flow will operate within capacity during the peak periods as illustrated in Figures 17 to 20.

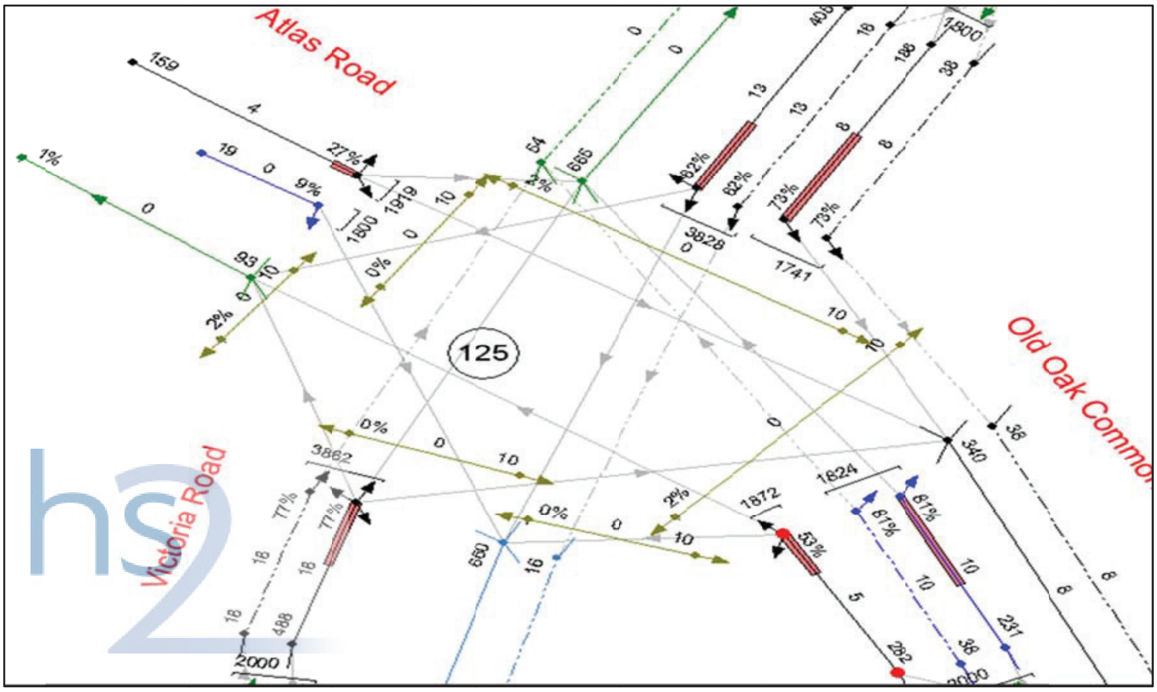
[7] (Zone 5_Old Oak Common_Base 2012_AM_Proposedbase1AV3.tnd and Zone 5_Old Oak Common_Base 2012_PM_Proposedbase1AV3.tnd)

Figure 17: Option 1A –2012 AM Peak Node 125 (Junction between Victoria Road and OOC Lane)



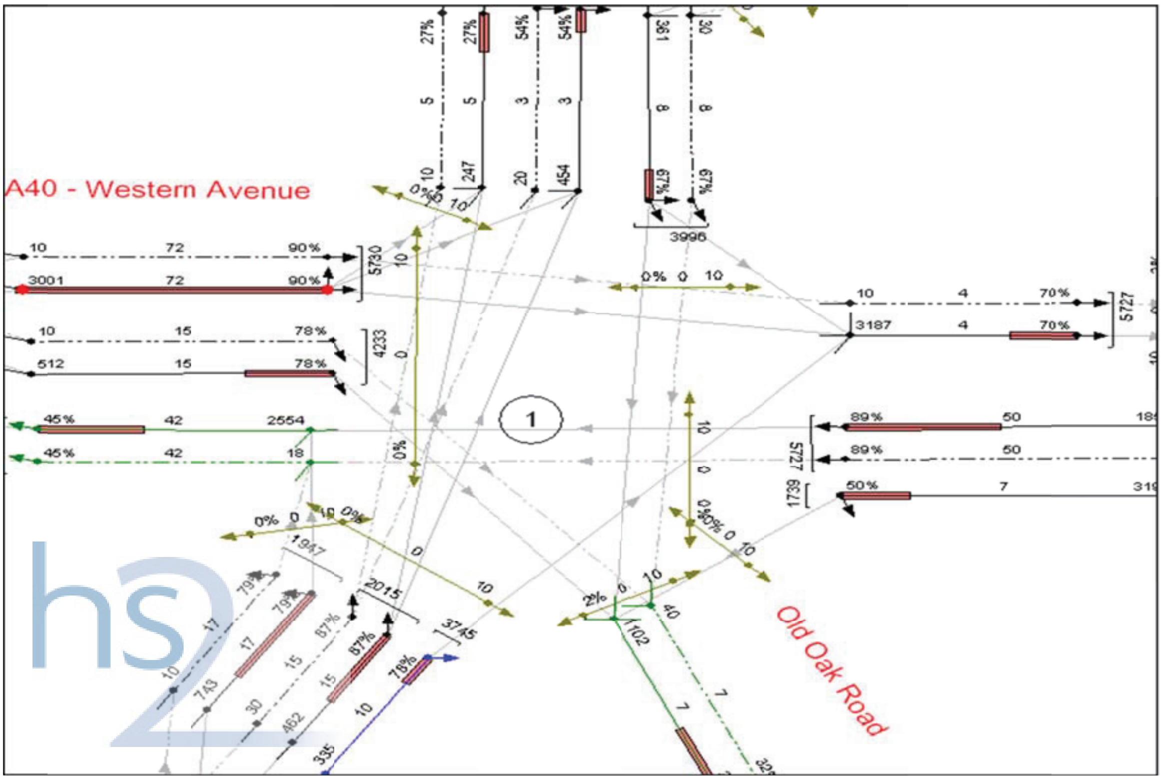
Note: Display on links - (Degree of Saturation - Mean Max queue - Flow in PCU)

Figure 18: Option 1A – 2012 PM Peak Node 125 (Junction between Victoria Road and OOC Lane)



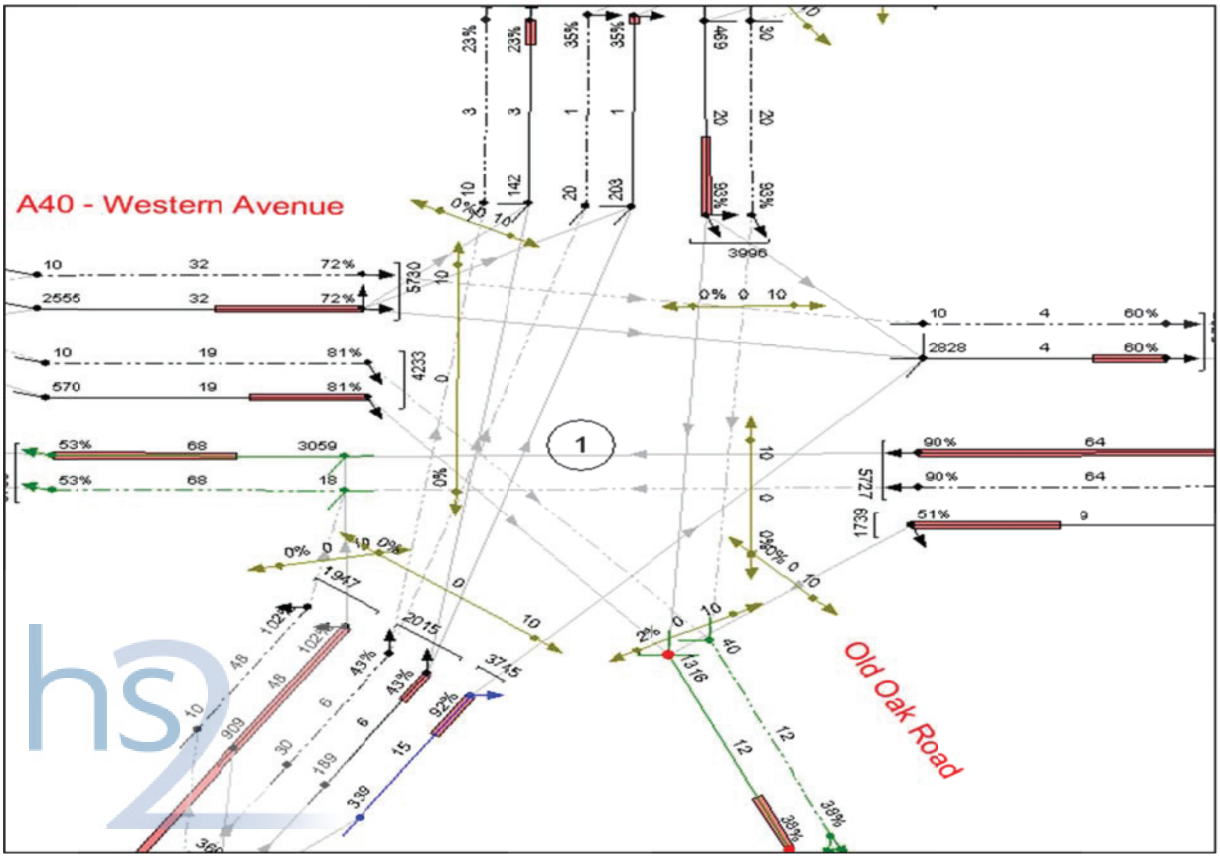
Note: Display on links - (Degree of Saturation - Mean Max queue - Flow in PCU)

Figure 19: Option 1A 2012 AM Peak Node 1 (Junction between A40 and OOC Lane)



Note: Display on links - (Degree of Saturation - Mean Max queue - Flow in PCU)

Figure 20: Option 1A 2012 PM Peak Node 1 (Junction between A40 and OOC Lane)

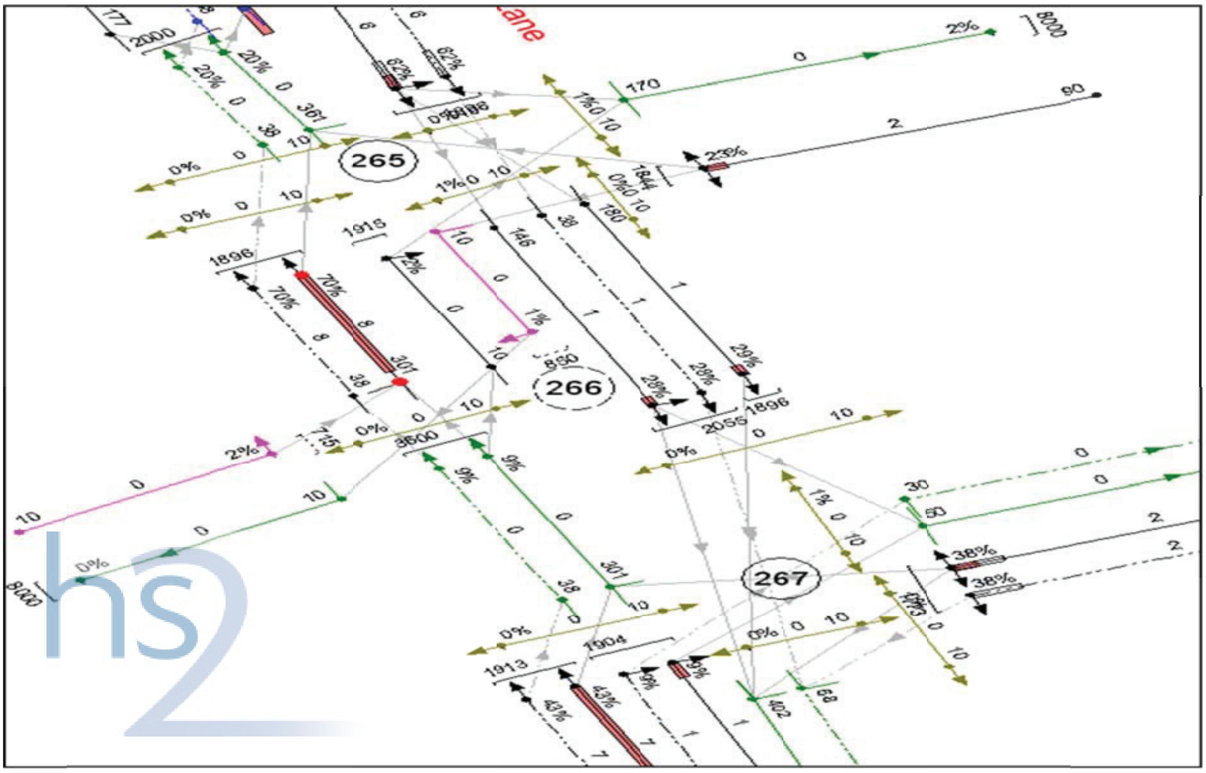


Note: Display on links - (Degree of Saturation - Mean Max queue - Flow in PCU)

4.6.3 The results show that the capacity of the junction between A40 and OOC Lane is similar to the base case (Refer Figure 12) as illustrated in Figure 20. The increase in demand through this junction due to the development is very small compared to the existing flow (0.8%) and hence operations at this junction are not adversely affected.

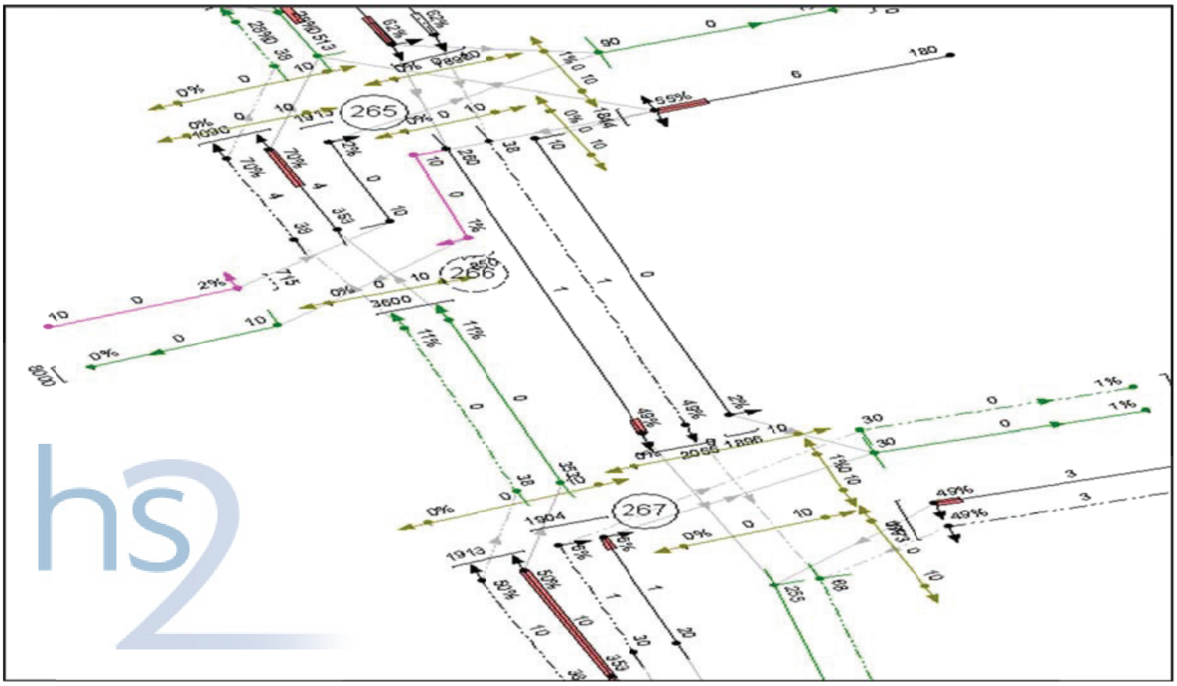
4.6.4 Results also indicate that proposed junctions operate within capacity during the peak periods as illustrated in Figure 21 and 22.

Figure 21: Option 1A – 2012 AM Peak Node 265 and 267 (Proposed Junctions)



Note: Display on links - (Degree of Saturation - Mean Max queue - Flow in PCU)

Figure 22: Option 1B – 2012 PM Peak Node 265 and 267 (Proposed Junctions)

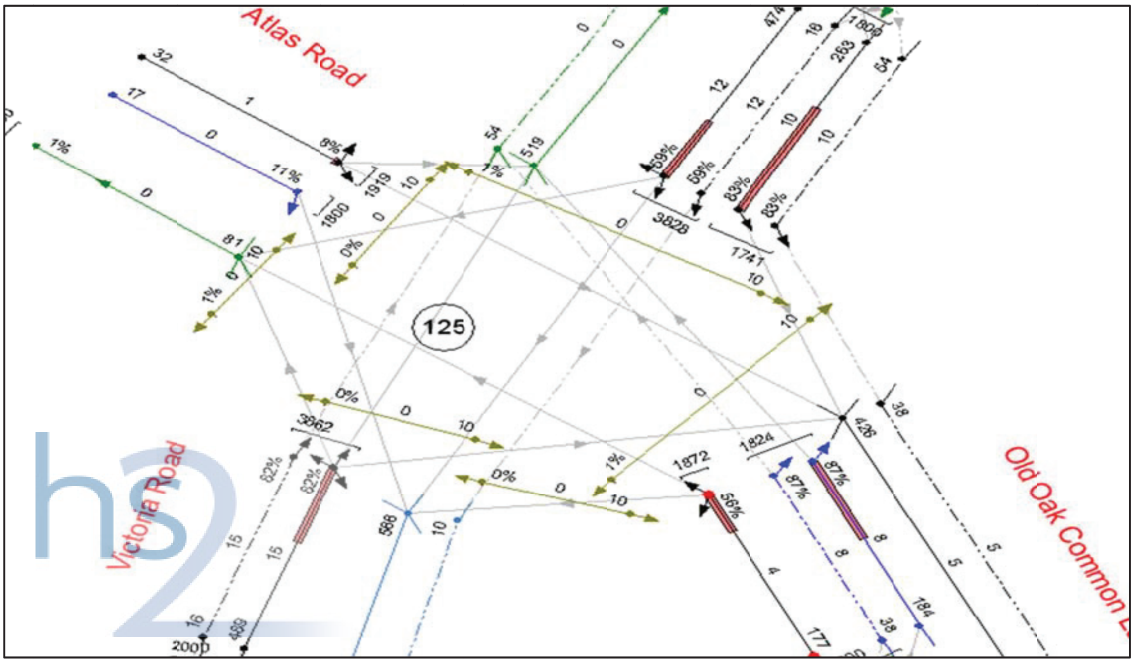


Note: Display on links - (Degree of Saturation - Mean Max queue - Flow in PCU)

Option 1B

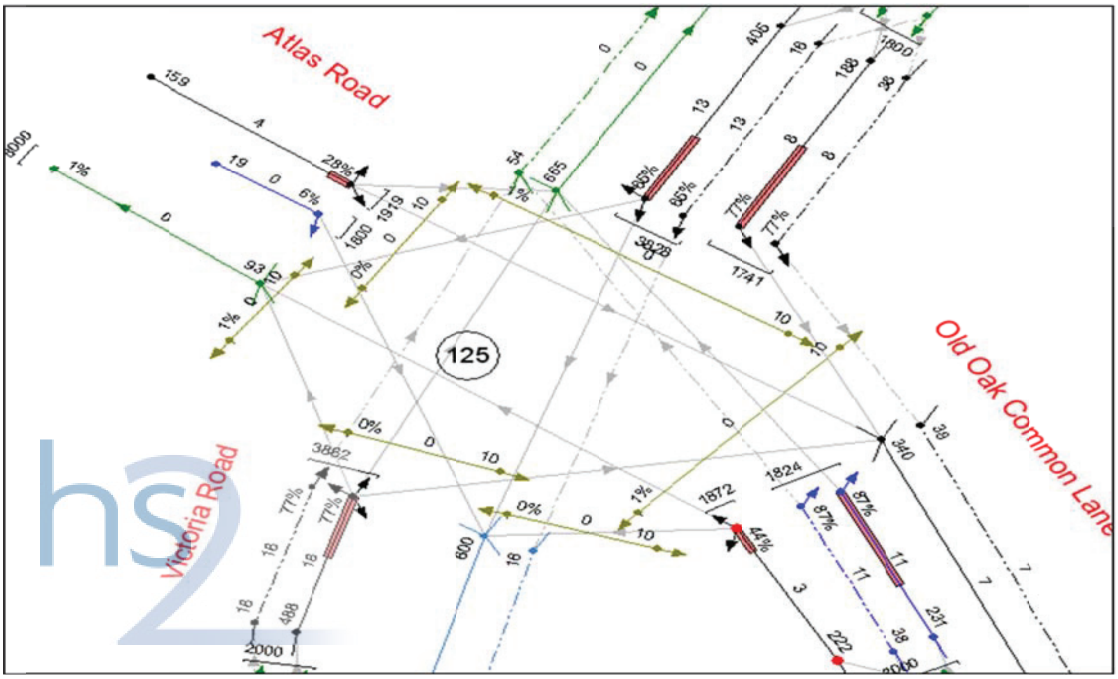
4.6.5 In this option the inbound flow from the west is distributed 50:50 from north and south as detailed in Table 5. Results indicate that the junction between Victoria Road and OOC Lane will operate within capacity similar to option 1A and the without any significant change as illustrated in Figures 23 and 24.

Figure 23: Option 1B – AM Peak Node 125 (Junction between Victoria Road and OOC Lane)



Note: Display on links - (Degree of Saturation - Mean Max queue - Flow in PCU)

Figure 24: Option 1B - PM Peak Node 125 (Junction between Victoria Road and OOC Lane)

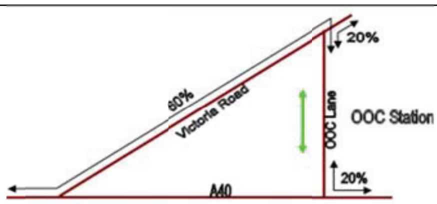


Note: Display on links - (Degree of Saturation - Mean Max queue - Flow in PCU)

4.7 2041 Options (Base + Development)

4.7.1 In this option the development flows were manually added to the predicted flows from 2041 base WeLHAM models[8] distributed as illustrated in Table 6 below.

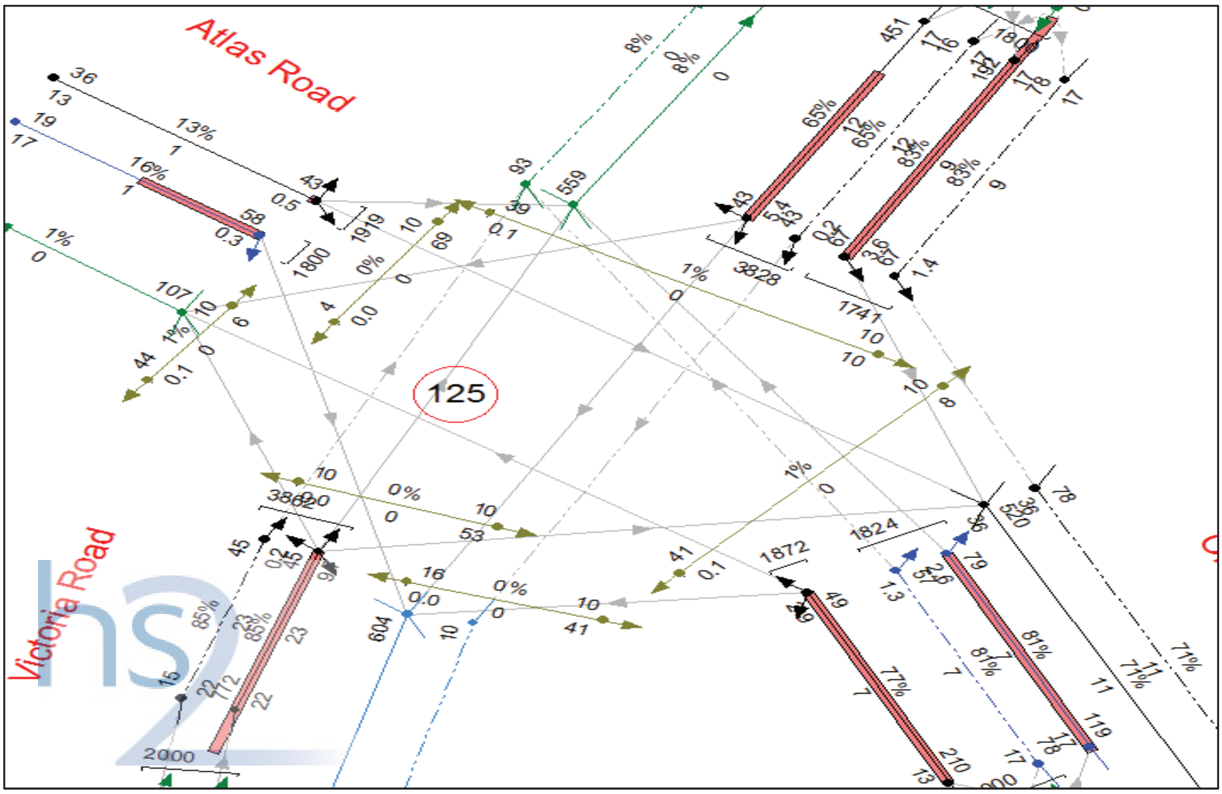
Table 6: Flow distribution 2041

Option	Trips generated (pcu)	Distribution	Base Flow (2041 AM)	Development Flow	Total (2041 + Development)
2041+ Development flows	320		Inbound 219:238:464 Outbound 91:155:86	Inbound 96:32:32 Outbound 96:32:32	Inbound 315:270:496 Outbound 187:197:118 34 buses along OOC Lane

[8] W1_R41_02C_REFC_MML_HS2_OOC_A_V1.UFS UFS and W1_R41_02C_REFC_MML_HS2_OOC_P_V1.UFS

4.7.2 Results from the TRANSYT models[9] indicate that the junction between Victoria Road and OOC Lane will operate within capacity during the peak periods as illustrated in Figures 25 and 26.

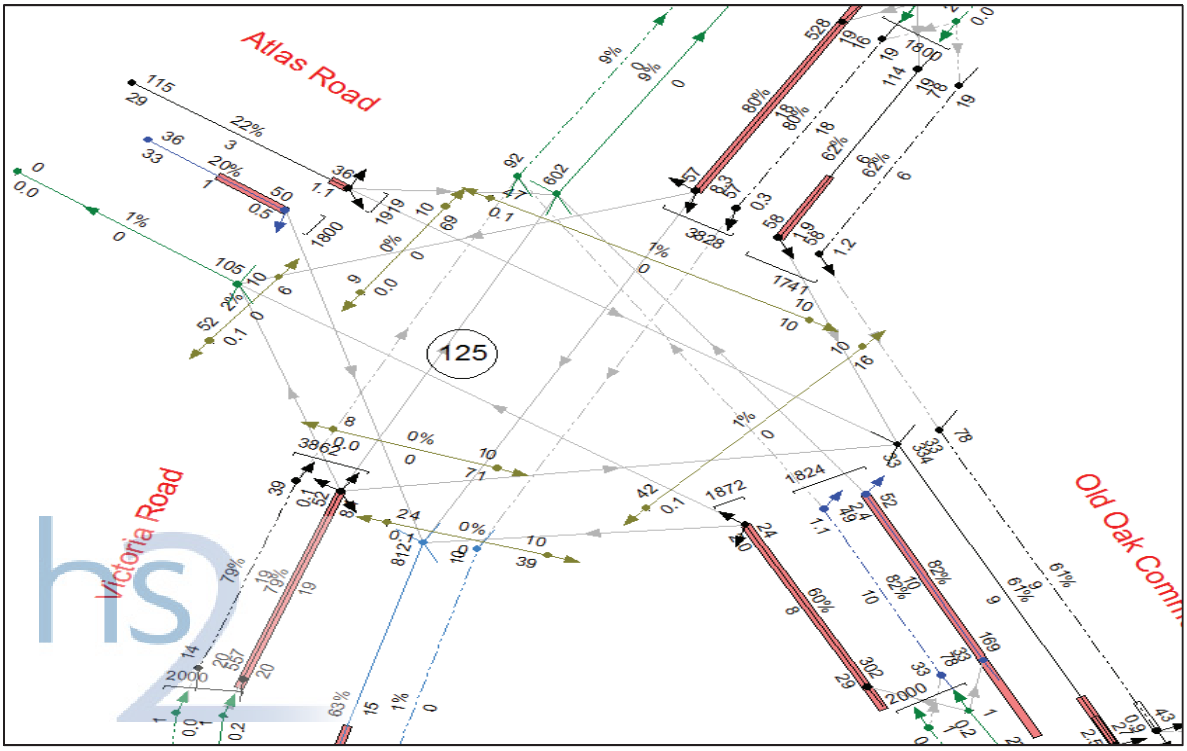
Figure 25: 2041 AM Peak (with development flow) Node 125 (Junction Victoria Road and OOC Lane)



Note: Display on links - (Degree of Saturation - Mean Max queue - Flow in PCU)

Zone 5_Old Oak Common_Base 2012_AM_Proposedbase1AV3.tnd, Zone 5_Old Oak Common_Base 2012_PM_Proposedbase1AV3.tnd

Figure 26: 2041 PM Peak (with development flow) Node 125 (Junction Victoria Road and OOC Lane)

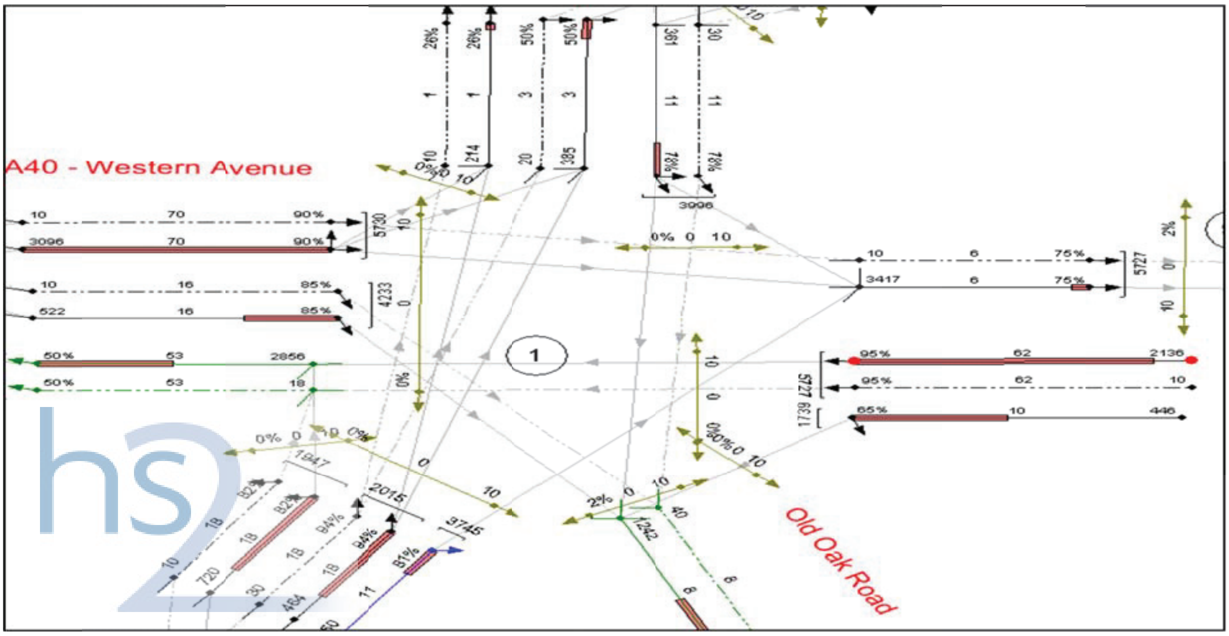


Note: Display on links - (Degree of Saturation - Mean Max queue - Flow in PCU)

4.7.3 Results from the TRANSYT models [10] without any development flow show that the junction on the A40 will operate over capacity during the peak periods as illustrated in Figures 27 and 28 for the junction between A40 and OOC Lane. This was expected as the junction has little capacity during both peak periods at present and increased flows will aggravate matters.

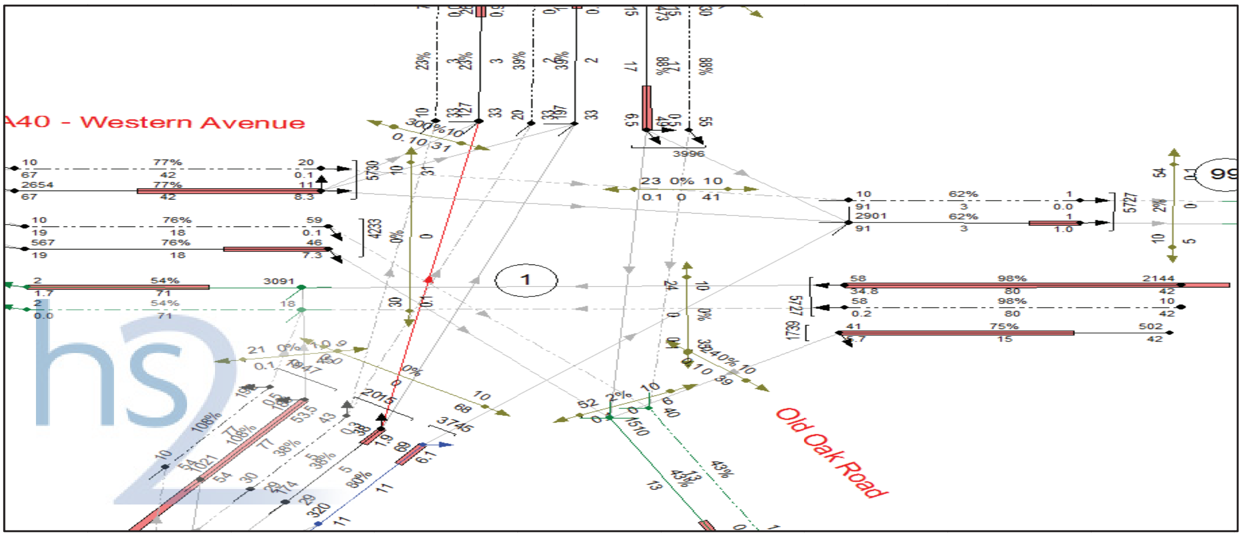
[10] Zone 5_Old Oak Common_Base 2041_AM_Pro_reference.tnd and Zone 5_Old Oak Common_Base 2041_PM_Pro_reference.tnd

Figure 27: 2041 AM Peak (Base flow) Node 1 (Junction between A40 and OOC Lane)



Note: Display on links - (Degree of Saturation - Mean Max queue - Flow in PCU)

Figure 28: 2041 PM Peak (Base Flow) Node 1 (Junction between A40 and OOC Lane)

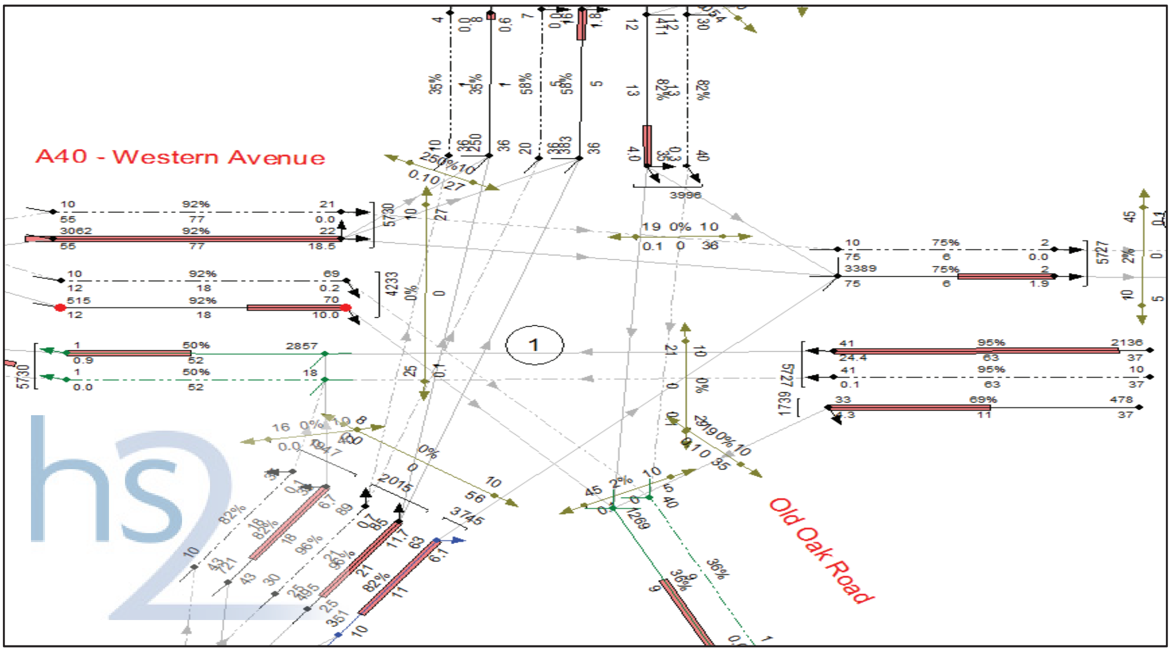


Note: Display on links - (Degree of Saturation - Mean Max queue - Flow in PCU)

4.7.4 Results show the junction between A40 and OOC Lane is over saturated. During the AM peak the DoS on the north bound approach on OOC Lane and the westbound approach on A40 are 94% and 95% respectively. During the PM peak the northbound left turn from OOC Lane and westbound approach on A40 are 108% and 98% respectively.

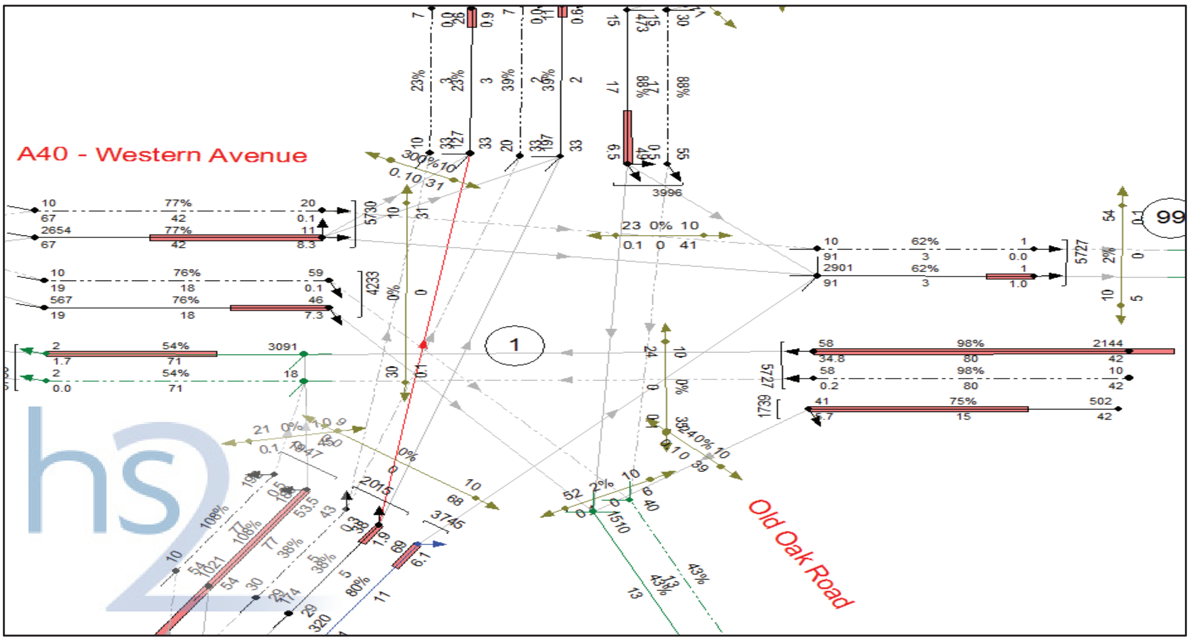
4.7.5 The increase in flow due to development will not affect the junction on the A40 significantly as illustrated in Figures 29 and 30. In the AM Peak north bound approach on OOC Lane will increase by 2% to 96% DoS. In the PM Peak worst affected links DoS will not increase.

Figure 29: 2041 AM Peak (Base flow+ development flow) Node 1 (Junction between A40 and OOC Lane)



Note: Display on links - (Degree of Saturation - Mean Max queue - Flow in PCU)

Figure 30: 2041 PM Peak (Base flow + Development flow) Node 1 (Junction between A40 and OOC Lane)



5 Report Summary

5.1.1 The planned Hs2 scheme is in accordance with the Mayors Transport Strategy and provides the catalyst for regeneration through subsequent development as part of the Opportunity Area Planning Framework.

5.1.2 At this stage queue lengths and degree of saturation were not validated as these have not yet been observed on site.

5.1.3 In the baseline analysis, the close correlation between observed and modelled journey times and flows on the main corridors of the area of influence show that the TRANSYT base model is robust and suitable for consideration of scheme options.

5.1.4 The assessment approach has superimposed all operational development traffic from the Hs2 scheme, including buses, on the forecast baseline reference flows without HS2. This thus assumes a worst case scenario and does not take into account any potential reassignment of general traffic away from the area. The assessment also excludes reduction in flows due to diverted trips that may also be accessing other local stations (ie East Acton or Willesden junction) and that may now divert to use the new OOC Station.

5.1.5 The assessment shows that increases in flow due to the operational traffic from the HS2 scheme, including the substantial increase in buses operating on OOC Lane, has negligible effects on the junction between A40 and Old Oak Common Lane.

5.1.6 The proposed modifications at the junction between Victoria Road and Old Oak Common Lane improve the capacity at this junction. This allows it to cater for the increase in flow of general traffic and buses as part of the HS2 scheme.

5.1.7 The results show that the junctions on the A40 will operate above capacity in 2041 with predicted increases in base flows. Flow increases at the same junctions due to the HS2 scheme in the PM peak, however, do not increase the DoSs of links that are over capacity. In the 2041 AM peak, the DoS of the northbound approach on OOC Lane increases by 2% to 96%.

5.1.8 Further iterations and re-optimisation of signal timings in the strategic model would be considered further at detailed design stage. At this stage the strategic models are principally used to provide a forecast model base on which to assess the incremental effect of the OOC operational traffic.

Appendix A layouts

Figure A 1 Gyratory (Victoria Road and Chase Road)

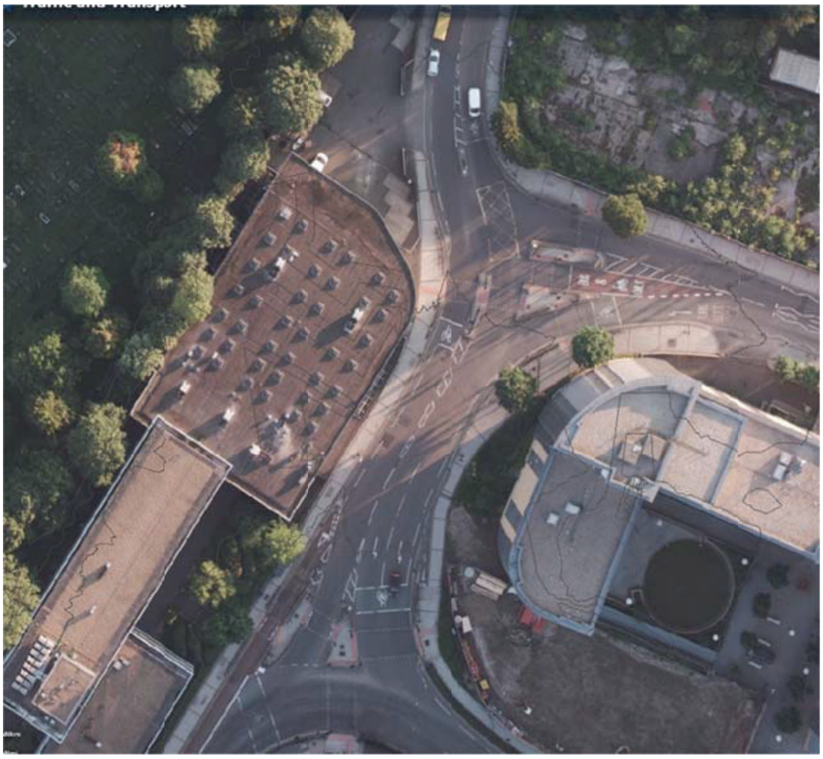
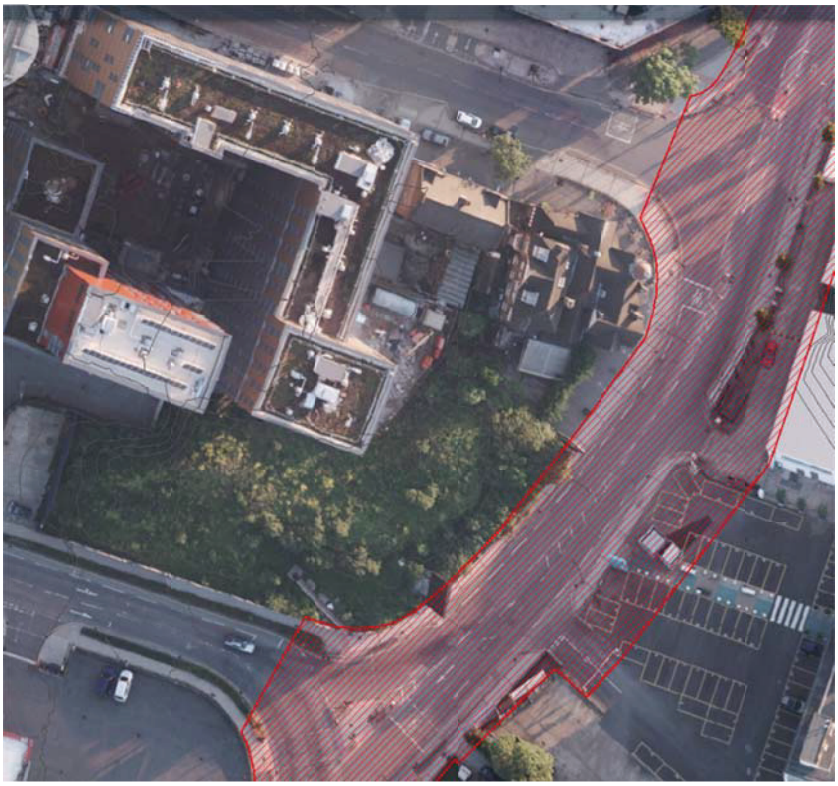
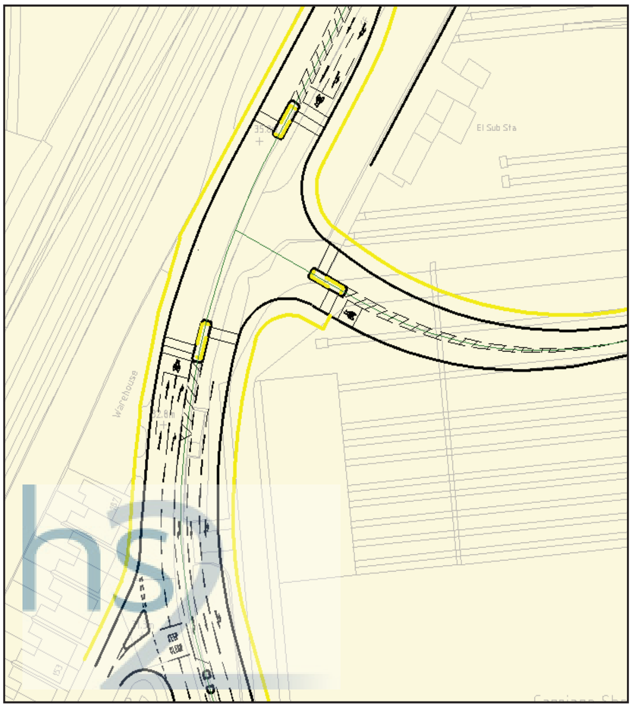


Figure A 2 Gyratory (Victoria Road)



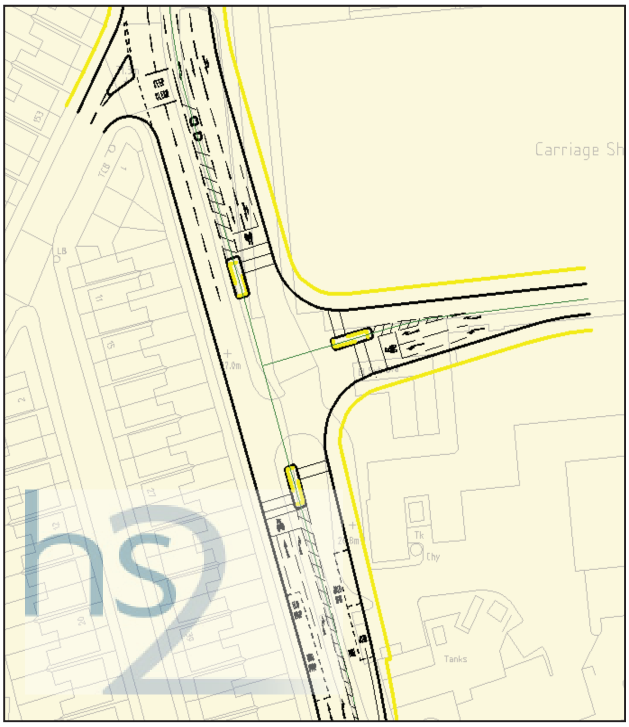
Appendix B Junction

Figure B 1 Proposed Junction at Old Oak Common Station



Source: C221_MMD_HW_DM3_010-00016

Figure B 2 Proposed Junction at Old Oak Common Station



Source: C221_MMD_HW_DM3_010-00016

Appendix C Flow Conversion

Table C 1 Flow conversion from SATURN to TRANSYT (AM Peak) compared with surveyed flows

			Observed	SATURN		TRANSYT		
SATURN Nodes			Oct-12	2012 (Base)	GEH		2012 (Base)	GEH
A Node	B Node	C Node	Flows (PCU)	Flows (PCU)		Link	Flows (PCU)	
Victoria Rd/ Atlas Rd/ Old Oak Common Lane								
65091	64129	64942	15	37	4.31	12510	37	4.31
65091	64129	64395	382	437	2.72	12510	331	2.72
						12512	106	
65091	64129	64998	219	233	0.93	12512	233	0.93
64998	64129	64395	98	96	0.20	12522	96	0.20
64998	64129	64942	12	21	2.22	12520	21	3.51
64998	64129	65091	137	174	2.97	12520	174	
64395	64129	64942	22	23	0.21	12531	23	
64395	64129	65091	271	335	3.68	12531	335	
64395	64129	64998	176	87	7.76	12531	87	1.12
64942	64129	65091	13	16	0.79	12540		
64942	64129	64998	7	16	2.65	12540	32	2.35
64942	64129	64395	20	17	0.70	12541	20	0.00
Victoria Rd/ Chandos Road								
64620	64635	64395	199	95	8.58	1414	95	
64620	64635	64623	35	23	2.23	1414	23	8.74
64623	64635	64620	20	0	6.32	1412	0	
64623	64635	64395	300	366	3.62	1412	366	2.48
64395	64635	64620	116	100	1.54	1410	100	
64395	64635	64623	436	422	0.68	1410	422	1.29
Old Oak Common Lane/Wulfstan Road								
64996	32313	32314	109	138	2.61	2910	138	
64996	32313	64394	281	214	4.26	2910	214	1.97
32314	32313	64394	61	39	3.11	2920	39	
32314	32313	64996	23	74	7.32	2920	74	2.92
64394	32313	64996	188	231	2.97	2930	231	
64394	32313	32314	10	7	1.03	2930	10	2.90
Old Oak Common Lane/Du Cane Road								
64261	32091	32269	41	17	4.46	26410	171	
64261	32091	32092	264	161	7.07	26410	161	1.51
32269	32091	32092	207	210	0.21	26420	210	
32269	32091	64261	44	22	3.83	26420	22	1.22
32092	32091	32269	314	474	8.06	26430	474	8.06
32092	32091	64261	225	217	0.54	26432	217	0.54
A40/Old Oak Common Lane								
64165	32092	32091	179	239	4.15	11	239	
64165	32092	32061	2439	2778	6.64	11	2778	7.52
64165	32092	32091	627	522	4.38	13	522	4.38
32061	32092	64165	1945	1862	1.90	12	1862	1.90
32061	32092	32090	290	279	0.65	18	279	0.65
32090	32092	64165	515	763	9.81	14	630	4.81
32090	32092	32091	353	452	4.93	15	452	4.93
32090	32092	32061	420	335	4.37	16	335	4.37
32091	32092	32061	48	70	2.86	17	70	
32091	32092	32090	377	301	4.13	17	301	2.71
East Acton /OOC lane Gyratory								
32081	32090	32092	678	896	7.77	1210	807	4.73

			Observed	SATURN		TRANSYT		
SATURN Nodes			Oct-12	2012 (Base)	GEH		2012 (Base)	GEH
A Node	B Node	C Node	Flows (PCU)	Flows (PCU)		Link	Flows (PCU)	
32081	32090	64166	479	450	1.35	1212	450	1.35
64160	32090	32092	671	582	3.56	1217	582	3.56
Acton Gyratory Victoria Road/ Wales Farm Road - Node 257								
64624	64101	64100	18	0	6.00	2572	0	
64624	64101	65101	460	460	0.00	2752	460	0.83
65101	64101	64624	329	350	1.14	25710	350	
65101	64101	64100	19	0	6.16	25710	10	0.64
64100	64101	65101	60	10	8.45	25720	30	
64100	64101	64624	96	16	10.69	25720	76	4.37
Acton Guratory Victoria Road/ Wales Farm Road- Node 239								
64101	65101	64097	501	488	0.58	2391	488	0.58
65100	65101	64101	689	828	5.05	23990	798	4.00
65100	65101	64097	384	350	1.77	23988	350	1.77
Acton Gyratory Victoria Road - Node 240								
64100	65100	65101	255	339	4.87	24034/2404	339	4.87
64099	65100	65101	869	839	1.03	2401	841	0.96
						2402		
64099	65100	64100	348	334	0.76	2402	334	0.76
Acton Gyratory Victoria Road/Chase Road - Node 256								
65092	64100	64101	51	0	10.10	2563	10	
65092	64100	65100	241	331	5.32	2563	321	2.21
64101	64100	65092	0	0		2564	0	
64101	64100	65100	20	0	6.32	2564	20	0.00
65100	64100	64101	100	0	14.14	2561	77	
65100	64100	65092	244	299	3.34	2561	249	0.98
A40/Wales Farm Road								
64098	64097	64069	3230	3230		481	1100	
						482	1100	
						483	1130	
64069	64097	64098	2187	2187		4812	1717	
						4813	468	
64069	64097	64215	450	450		4813	450	
65101	64097	64069	441	441		4811	449	
64101	64097	64215	655	655		488	231	
						489	368	
65101	64097	64098	220	220		485	50	
						486	50	
						487	120	Same as SATURN
A40/Victoria Rd/ Horn Lane								
64097	64098	64386	2407	2407		201	807	
						202	800	
						203	800	
64215	64098	64097	537	537		204	300	
						205	237	
64215	64098	64099	818	818		206	300	
						207	300	
						208	218	
64215	64098	64386	160	160		208	160	
64386	64098	64097	2693	2693		210	999	
						211	950	
						212	759	Same as SATURN

			Observed	SATURN			TRANSYT	
SATURN Nodes			Oct-12	2012 (Base)	GEH		2012 (Base)	GEH
A Node	B Node	C Node	Flows (PCU)	Flows (PCU)		Link	Flows (PCU)	
64386	64098	64099	341	341		212	341	
Note SATURN Flow - ZONE 5_Old Oak Common_Saturn Data for TRANSYT_2012_AM_run12.doc Observed Flow - Appendix V, V1 and V2 in C221 Transport Survey Working Paper 260413.docx Zone 5_Old Oak Common_Base 2012_AM_V3.tnd								

Table C 2 Flow conversion from SATURN to TRANSYT (PM Peak) compared with surveyed flows

			Observed	SATURN			TRANSYT	
SATURN Nodes			Oct-12	2012 (Base)	GEH		2012 (Base)	GEH
A Node	B Node	C Node	Flows (PCU)	Flows (PCU)		Link	Flows (PCU)	
Victoria Rd/ Atlas Rd/ Old Oak Common Lane								
65091	64129	64942	26	37	1.96	12510	37	1.96
65091	64129	64395	367	384	0.88	12510	268	0.88
						12512	116	
65091	64129	64998	115	178	5.21	12512	178	5.21
64998	64129	64395	261	201	3.95	12522	201	3.95
64998	64129	64942	10	14	1.15	12520	14	1.89
64998	64129	65091	177	148	2.27	12520	148	
64395	64129	64942	24	42	3.13	12531	42	
64395	64129	65091	399	325	3.89	12531	325	
64395	64129	64998	112	77	3.60	12531	77	4.11
64942	64129	65091	34	16	3.60	12540		
64942	64129	64998	16	16	0.00	12540	32	2.81
64942	64129	64395	33	17	3.20	12541	20	2.53
Victoria Rd/ Chandos Road								
64620	64635	64395	172	133	3.16	1414	133	
64620	64635	64623	33	10	4.96	1414	10	4.70
64623	64635	64620	24	0	6.93	1412	0	
64623	64635	64395	354	288	3.68	1412	288	4.93
64395	64635	64620	180	96	7.15	1410	96	
64395	64635	64623	502	470	1.45	1410	470	4.64
Old Oak Common Lane/Wulfstan Road								
64996	32313	32314	62	51	1.46	2910	51	
64996	32313	64394	174	190	1.19	2910	190	0.32
32314	32313	64394	32	128	10.73	2920	128	
32314	32313	64996	174	147	2.13	2920	147	4.45
64394	32313	64996	147	226	5.78	2930	226	
64394	32313	32314	13	0	5.10	2930	0	4.75
Old Oak Common Lane/Du Cane Road								
64261	32091	32269	55	26	4.56	26410	26	
64261	32091	32092	274	326	3.00	26410	326	1.25
32269	32091	32092	43	37	0.95	26420	37	
32269	32091	64261	132	139	0.60	26420	139	0.08
32092	32091	32269	140	223	6.16	26430	223	6.16
32092	32091	64261	192	122	5.59	26432	189	0.22
A40/Old Oak Common Lane								
64165	32092	32091	110	155	3.91	11	155	3.52

			Observed	SATURN		TRANSYT		
SATURN Nodes			**Oct-12**	**2012 (Base)**	**GEH**		**2012 (Base)**	**GEH**
A Node	**B Node**	**C Node**	**Flows (PCU)**	**Flows (PCU)**		**Link**	**Flows (PCU)**	
64165	32092	32061	2280	2410	2.68	11	2410	
64165	32092	32091	632	580	2.11	13	580	2.11
32061	32092	64165	1975	2106	2.90	12	2106	2.90
32061	32092	32090	251	347	5.55	18	347	5.55
32090	32092	64165	702	974	9.40	14	921	7.69
32090	32092	32091	318	199	7.40	15	256	3.66
32090	32092	32061	282	339	3.23	16	339	3.23
32091	32092	32061	53	49	0.56	17	49	0.56
32091	32092	32090	400	410	0.50	17	410	0.50
East Acton /OOC lane Gyratory								
32081	32090	32092	733	898	5.78	1210	868	4.77
32081	32090	64166	351	763	17.46	1212	443	4.62
64160	32090	32092	616	615	0.04	1217	615	0.04
Acton Gyratory Victoria Road/ Wales Farm Road - Node 257								
64624	64101	64100	18	0	6.00	2572	0	
64624	64101	65101	460	487	1.24	2752	487	0.41
65101	64101	64624	329	272	3.29	25710	272	
65101	64101	64100	19	0	6.16	25710	10	3.72
64100	64101	65101	60	36	3.46	25720	36	
64100	64101	64624	16	16	0.00	25720	16	3.00
Acton Gyratory Victoria Road/ Wales Farm Road- Node 239								
64101	65101	64097	423	497	3.45	2391	497	3.45
65100	65101	64101	124	272	10.52	23988	272	10.52
65100	65101	64097	720	696	0.90	23990	700	0.75
Acton Gyratory Victoria Road - Node 240								
64100	65100	65101	294	274	1.19	2403/2404	274	1.19
64099	65100	65101	572	704	5.23	2401	592	0.83
						2402		
64099	65100	64100	243	236	0.45	2402	325	4.87
Acton Gyratory Victoria Road/Chase Road - Node 256								
65092	64100	64101	80	0	12.65	2563	20	
65092	64100	65100	299	264	2.09	2563	264	5.22
64101	64100	65092	4	0	2.83	2564	0	
64101	64100	65100	11	0	4.69	2564	10	1.41
65100	64100	64101	86	0	13.11	2561	91	
65100	64100	65092	178	201	1.67	2561	201	1.68
A40/Wales Farm Road								
64098	64097	64069		2782		483	2787	
64069	64097	64098		2799		4812	1790	
						4813	1019	
64069	64097	64215		294		4813	294	
65101	64097	64069		340		4811	340	
64101	64097	64215		411		488	149	
						489	252	
65101	64097	64098		442		485	150	
						486	150	Same as
						487	142	SATURN
A40/Victoria Rd/ Horn Lane								
64097	64098	64386		3241		201	1141	
						202	1000	
						203	1100	

			Observed	SATURN		TRANSYT		
SATURN Nodes			Oct-12	2012 (Base)	GEH		2012 (Base)	GEH
A Node	B Node	C Node	Flows (PCU)	Flows (PCU)		Link	Flows (PCU)	
64215	64098	64097		519		204	300	Same as SATURN
						205	219	
64215	64098	64099		703		206	255	
						207	277	
						208	173	
64215	64098	64386		141		208	141	
64386	64098	64097		2266		211	1487	
						212	779	
64386	64098	64099		131		212	131	

Note
SATURN Flow - ZONE 5_Old Oak Common_Saturn Data for TRANSYT_2012_AM_run12.doc
Observed Flow - Appendix V, V1 and V2 in C221 Transport Survey Working Paper 260413.docx
Zone 5_Old Oak Common_Base 2012_PM_V3.tnd

Appendix D OOC Lane Saturation Flow Measurements

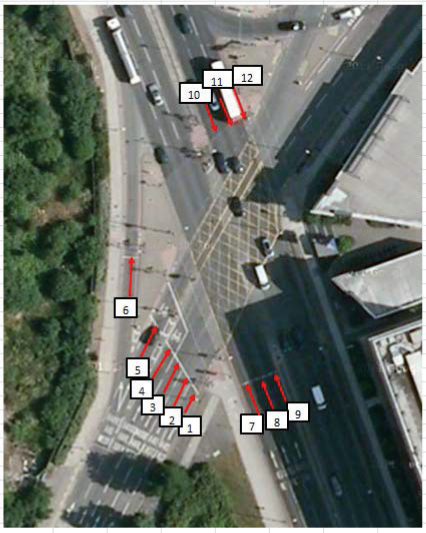
(Refer – WP_225_a_OOC Sat flow measurement.xls)

SATURATION FLOW MEASUREMENT

Junction : Horn Ln/Western Avenue			
Link :	Horn Ln Right turn link 1		
Enumerator : DZ		Time & Date : 23/07/13 AM Peak	
	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	7	15.6	1615
2	4.4	7.2	2200
3	5	7.9	2278
4	6	10.1	2139
5	4	7.9	1823
6	5	8.2	2195
7	4.5	8.2	1976
8	4	8.3	1735
9	7.4	12.4	2148
10	6	13.3	1624
		Average Sat	1973

SATURATION FLOW MEASUREMENT

Junction : Horn Ln/Western Avenue			
Link :	Horn Ln Right turn link 2		
Enumerator : DZ		Time & Date : 23/07/13 AM Peak	
	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	6.4	8.6	2679
2	5	8.5	2118
3	5	7.9	2278
4	5	8.9	2022
5	4	8.1	1778
6	5	9.2	1957
7	7.5	11.8	2288
8	6	10.7	2019
9	4.5	10.5	1543
10	8	16.5	1745
		Average Sat	2043



SATURATION FLOW MEASUREMENT

Junction : Horn Ln/Western Avenue			
Link :	Horn Ln Ahead link 3		
Enumerator : DZ		Time & Date : 23/07/13 AM Peak	
	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	7	12.8	1969
2	6.5	10.5	2229
3	6	11.3	1912
4	5.4	8.8	2209
5	7.5	14.4	1875
6	7	13.2	1909
7	8	10.7	2692
8	5	10.3	1748
9	5.5	8.9	2225
10	5	9.6	1875
11			
		Average Sat	2064

SATURATION FLOW MEASUREMENT

Junction : Horn Ln/Western Avenue			
Link :	Horn Ln Ahead link 4		
Enumerator : DZ		Time & Date : 23/07/13 AM Peak	
	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	9	12.2	2656
2	6	12.5	1728
3	6	11.6	1862
4	8	13.3	2165
5	7	15.4	1636
6	7.5	11.8	2288
7	7.5	14.1	1915
8	8	9.8	2939
9	4	9.7	1485
10	6.5	11.5	2035
		Average Sat	2071

SATURATION FLOW MEASUREMENT

Junction : Horn Ln/Western Avenue			
Link :	Horn Ln Ahead link 5		
Enumerator : DZ		Time & Date : 23/07/13 AM Peak	
	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	11	18	2200
2	5	6.5	2769
3	6	11.9	1815
4	5	7.7	2338
5	5	10.2	1765
6	7.5	10.9	2477
7	8	13.4	2149
8	6	8.7	2483
9	5	11	1636
10	7	9.9	2545
11			
		Average Sat	2218

SATURATION FLOW MEASUREMENT

Junction : Horn Ln/Western Avenue			
Link :	Horn Ln Left turn 6		
Enumerator : DZ		Time & Date : 23/07/13 AM Peak	
	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1			#DIV/0!
2			#DIV/0!
3			#DIV/0!
4			#DIV/0!
5			#DIV/0!
6			#DIV/0!
7			#DIV/0!
8			#DIV/0!
9			#DIV/0!
10			#DIV/0!
11			
		Average Sat	#DIV/0!

SATURATION FLOW MEASUREMENT

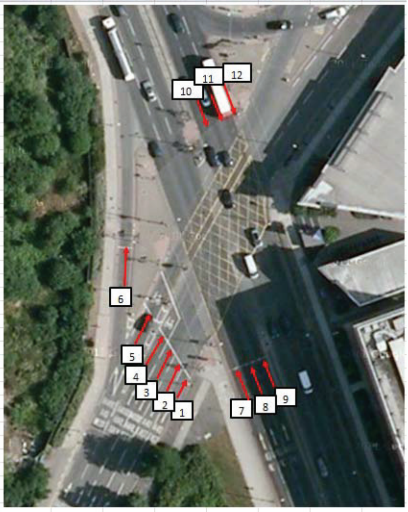
Junction : Horn Ln/Western Avenue
Link : Western Avenue NB Ahead link 7
Enumerator : DZ — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	5	7.7	2338
2	7	13.1	1924
3	5	9.4	1915
4	7	7.4	3405
5	7.5	12.3	2195
6	6	8.2	2634
7	5.5	9.4	2106
8	7	11.4	2211
9	7	8.9	2831
10	8	9.4	3064
		Average Sat	2462
			2180
	6	7.7	2805
	6.4	10.9	2114

SATURATION FLOW MEASUREMENT

Junction : Horn Ln/Western Avenue
Link : Western Avenue NB Ahead link 8
Enumerator : DZ — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	5	9.6	1875
2	8	14.1	2043
3	8	13.4	2149
4	6	9.8	2204
5	9.4	15.8	2142
6	9.5	16.9	2024
7	6	8.9	2427
8	5.5	11.7	1692
9	5.5	9.4	2106
10	5.5	8.1	2444
		Average Sat	2111



SATURATION FLOW MEASUREMENT

Junction : Horn Ln/Western Avenue
Link : Western Avenue NB Ahead link 9
Enumerator : DZ — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	9	15.7	2064
2	5	8.3	2169
3	10	15.9	2264
4	6	9.9	2182
5	5.4	9.3	2090
6	6	10.2	2118
7	8	10.4	2769
8	7.5	11.5	2348
9	5	9.4	1915
10	6	9.9	2182
11	6	10.3	2097
		Average Sat	2200
			2143

SATURATION FLOW MEASUREMENT

Junction : Horn Ln/Western Avenue
Link : Western Avenue SB Ahead link 10
Enumerator : DZ — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow	
	PCU	s	PCU/hour	
1	7	10	2520	
2	8	13.5	2133	
3	6.4	11.9	1936	
4	6	12.7	1701	
5	5	9.6	1875	
6	6	13.8	1565	
7	7	12.6	2000	
8	6	9.8	2204	
9	8.4	14.3	2115	
10	7	12.7	1984	
	6	11.2	1929	
	6.4	12.2	1889	
	7	12.4	2032	
	5	8.1	2222	
		Average Sat	2008	1968

SATURATION FLOW MEASUREMENT

Junction : Horn Ln/Western Avenue
Link : Western Avenue SB Ahead link 11
Enumerator : DZ — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	6	8.7	2483
2	9	16.1	2012
3	6	11.3	1912
4	7	11.2	2250
5	6	9.1	2374
6			#DIV/0!
7			#DIV/0!
8			#DIV/0!
9			#DIV/0!
10			#DIV/0!
11			
		Average Sat	2206

SATURATION FLOW MEASUREMENT

Junction : Horn Ln/Western Avenue
Link : Western Avenue SB Ahead link 12
Enumerator : DZ — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1			#DIV/0!
2			#DIV/0!
3			#DIV/0!
4			#DIV/0!
5			#DIV/0!
6			#DIV/0!
7			#DIV/0!
8			#DIV/0!
9			#DIV/0!
10			#DIV/0!
11			
		Average Sat	#DIV/0!

SATURATION FLOW MEASUREMENT

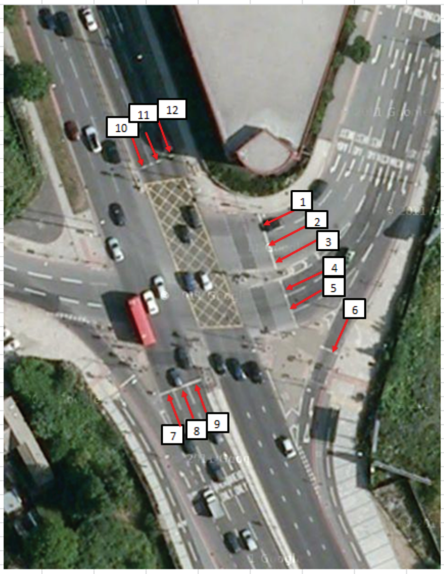
Junction : Wales Farm Rd/Western Avenue
Link : Wales Farm Rd Right turn 1
Enumerator : BR — Time & Date : 23/07/13 AM Pe

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1			#DIV/0!
2			#DIV/0!
3			#DIV/0!
4			#DIV/0!
5			#DIV/0!
6			#DIV/0!
7			#DIV/0!
8			#DIV/0!
9			#DIV/0!
10			#DIV/0!
		Average Sat	#DIV/0!

SATURATION FLOW MEASUREMENT

Junction : Wales Farm Rd/Western Avenue
Link : Wales Farm Rd Right turn 2
Enumerator : BR — Time & Date : 23/07/13 AM Peal

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	4	7.12	2022
2	4	7.14	2017
3	5	9.22	1952
4	4	8.12	1773
5	5.5	11.23	1763
6	4	9.22	1562
7			
8			
9			
10			
		Average Sat	1848



SATURATION FLOW MEASUREMENT

Junction : Wales Farm Rd/Western Avenue
Link : Wales Farm Rd Rightt turn 3
Enumerator : BR — Time & Date : 23/07/13 AM Pe

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	9.5	19.47	1757
2	10.5	22.5	1680
3	9	18.62	1740
4	5.5	10.22	1937
5	4	7.94	1814
6	5	8.32	2163
7			
8			
9			
10			
11			
		Average Sat	1849

SATURATION FLOW MEASUREMENT

Junction : Wales Farm Rd/Western Avenue
Link : Wales Farm Rd ahead 4
Enumerator : BR — Time & Date : 23/07/13 AM Peal

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	5.5	11.12	1781
2	4	7.84	1837
3	8	16.47	1749
4	5	10.22	1761
5	4	8.2	1756
6	6.5	13.32	1757
7			#DIV/0!
8			#DIV/0!
9			#DIV/0!
10			
		Average Sat	1773

SATURATION FLOW MEASUREMENT

Junction : Wales Farm Rd/Western Avenue
Link : Wales Farm Rd Ahead 5
Enumerator : BR — Time & Date : 23/07/13 AM Pe

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	6.5	11.2	2089
2	4	8.2	1756
3	7	15.2	1658
4	7	14.2	1775
5	4	8.3	1735
6	5	9.8	1837
7			#DIV/0!
8			#DIV/0!
9			#DIV/0!
10			#DIV/0!
11			
		Average Sat	1808

Notes: Movement 5 - flare around 2 vehicles per cycle
Movement 1 - not many vehicles to measure sat flow

SATURATION FLOW MEASUREMENT

Junction : Wales Farm Rd/Western Avenue
Link : Wales Farm Rd Left turn 6
Enumerator : BR — Time & Date : 23/07/13 AM Peal

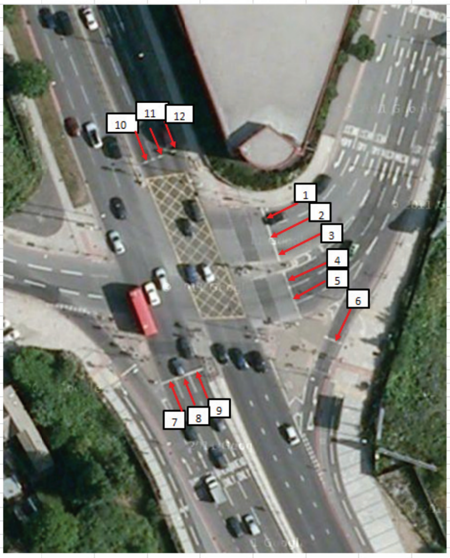
	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	12	22.22	1944
2	14	22.24	2266
3	11	20.28	1953
4	6	9	2400
5	15	25.32	2133
6	16	23.12	2491
7	14	24.78	2034
8	16	25.5	2259
9	14	23.84	2114
10	15	24.74	2183
11			
		Average Sat	2178

SATURATION FLOW MEASUREMENT
Junction : Wales Farm Rd/Western Avenue
Link : Western Avenue NB Ahead link 7
Enumerator : BR — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	6	11.22	1925
2	5	10.32	1744
3	7	13.44	1875
4	5	10.32	1744
5	4.5	8.22	1971
6	4	7.32	1967
7	5.5	11.02	1797
8	7	12.65	1992
9	8	15.14	1902
10			#DIV/0!
		Average Sat	1880

SATURATION FLOW MEASUREMENT
Junction : Wales Farm Rd/Western Avenue
Link : Western Avenue NB Ahead link 8
Enumerator : BR — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	13	24.12	1940
2	14	23.42	2152
3	12	23.24	1859
4	8	17.24	1671
5	6	10.32	2093
6	9	17.24	1879
7	13	21.21	2207
8	8	16.24	1773
9	10	19.33	1862
10	10.5	21.32	1773
		Average Sat	1921



SATURATION FLOW MEASUREMENT
Junction : Wales Farm Rd/Western Avenue
Link : Western Avenue NB Ahead link 9
Enumerator : BR — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	11	20.6	1922
2	12.5	22.5	2000
3	13	24.12	1940
4	13.5	25.84	1881
5	20	37.37	1927
6	10	19.62	1835
7	12	21.42	2017
8	14	25.92	1944
9	8.5	16.42	1864
10	10	20.14	1787
11	9.5	21.12	1619
		Average Sat	1885

SATURATION FLOW MEASUREMENT
Junction : Wales Farm Rd/Western Avenue
Link : Western Avenue SB Ahead link 10
Enumerator : BR — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	39.5	73.6	1932
2	44	80.5	1968
3	38	71.22	1921
4	41.5	77.19	1935
5	29	46	2270
6	38.5	73.6	1883
7	39	67.81	2070
8	40.5	69.1	2110
9	42	72.13	2096
10	38.5	73.6	1883
		Average Sat	2007

SATURATION FLOW MEASUREMENT
Junction : Wales Farm Rd/Western Avenue
Link : Western Avenue SB Ahead link 11
Enumerator : BR — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	41	77.19	1912
2	42	79.25	1908
3	38	77.4	1767
4	43	76.13	2033
5	44	76.97	2058
6	36.5	72.41	1815
7	38.5	72.03	1924
8	36	67.18	1929
9	42	78.18	1934
10	40	70.09	2055
11			
		Average Sat	1934

SATURATION FLOW MEASUREMENT
Junction : Wales Farm Rd/Western Avenue
Link : Western Avenue SB Ahead link 12
Enumerator : BR — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	38	63.37	2159
2	43	73.63	2102
3	24	39.87	2167
4	29	48.77	2141
5			#DIV/0!
6			#DIV/0!
7			#DIV/0!
8			#DIV/0!
9			#DIV/0!
10			#DIV/0!
11			
		Average Sat	2142

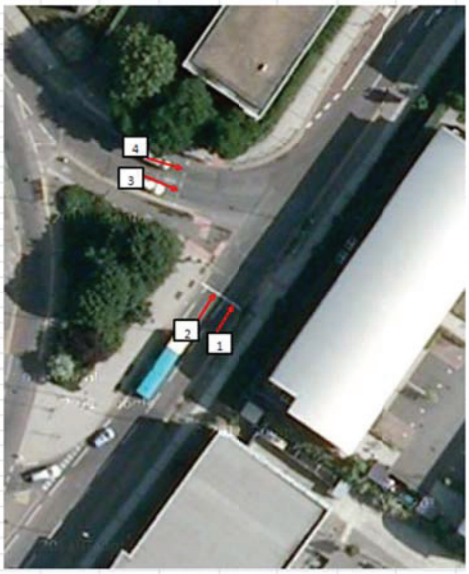
Note: Movement 12 - Broken down vehicle blocking the lane hence only 3 measurement possible

SATURATION FLOW MEASUREMENT
Junction : Victoria Rd/Park Royal Rd
Link : Victoria Rd Ahead link 1
Enumerator : DZ — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	4.5	8.22	1971
2	6	10.02	2156
3	5	8.89	2025
4	5.5	10.35	1913
5	4.5	7.62	2126
6	5.5	10.1	1960
7	6	11.12	1942
8	6.5	12.42	1884
9	4.5	7.5	2160
10	4	9.01	1598
		Average Sat	1974

SATURATION FLOW MEASUREMENT
Junction : Victoria Rd/Park Royal Rd
Link : Victoria Rd Ahead link 2
Erumerator : DZ — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	4.5	9.84	1646
2	5	10.66	1689
3	6	12.88	1677
4	6	11	1964
5	5.5	11.22	1765
6	4	8.1	1778
7	5	9.1	1978
8	4	7.32	1967
9	6.7	10.32	2337
10	7	14.1	1787
		Average Sat	1859



SATURATION FLOW MEASUREMENT
Junction : Victoria Rd/Park Royal Rd
Link : Park Royal Rd Ahead link 3
Enumerator : DZ — Time & Date : 23/07/13 AM Peak

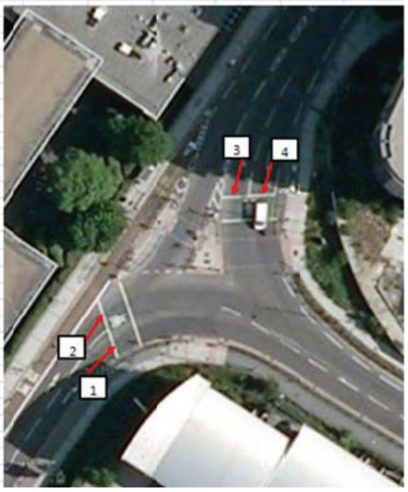
	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	6	12.38	1745
2	6.5	12.63	1853
3	6	13.09	1650
4	5.5	10	1980
5	6	9.56	2259
6	4	7.32	1967
7	5	10.21	1763
8	6	11.31	1910
9	4	8.32	1731
10	4	7.5	1920
11			
		Average Sat	1878

SATURATION FLOW MEASUREMENT
Junction : Victoria Rd/Park Royal Rd
Link : Park Royal Rd Ahead link 4
Erumerator : DZ — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	6	11.68	1849
2	5.5	12.32	1607
3	6	11.32	1908
4	5	9.25	1946
5	5.5	11.23	1763
6	5.5	9.04	2190
7	7	13.42	1878
8	4	7.32	1967
9	5	10.12	1779
10	4	8.12	1773
		Average Sat	1866

SATURATION FLOW MEASUREMENT			
Junction : Victoria Rd Node A			
Link :	Victoria Rd NB Right turn link 1		
Enumerator : DZ		**Time & Date : 23/07/13 AM Peak**	
	Vehicles	**Time**	**Saturation flow**
	PCU	s	PCU/hour
1	9	19.82	1635
2	7	15.28	1649
3	4	7.69	1873
4	11	23	1722
5	9.5	19.53	1751
6	5	10.21	1763
7	6	11.32	1908
8	7	14.12	1785
9	8	15.13	1904
10	5	9.18	1961
		Average Sat	**1795**

SATURATION FLOW MEASUREMENT			
Junction : Victoria Rd Node A			
Link :	Victoria Rd NB Ahead/Right link 2		
Enumerator : DZ		**Time & Date : 23/07/13 AM Peak**	
	Vehicles	**Time**	**Saturation flow**
	PCU	s	PCU/hour
1	9	20.15	1608
2	10	17.37	2073
3	11	22.66	1748
4	9	20.44	1585
5	9	19.03	1703
6	4	7.5	1920
7	5.5	11.1	1784
8	6	10.9	1982
9	4	7.3	1973
10	7	14.4	1750
		Average Sat	**1812**

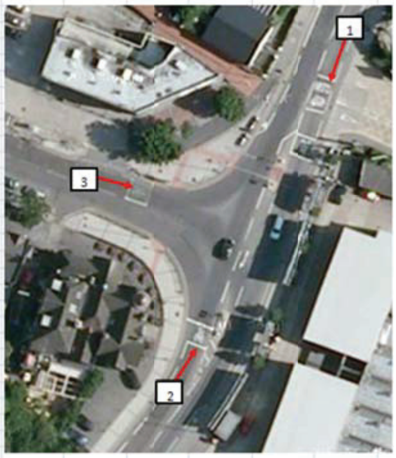


SATURATION FLOW MEASUREMENT			
Junction : Victoria Rd Node A			
Link :	Victoria Rd SB left turn link 3		
Enumerator : DZ		**Time & Date : 23/07/13 AM Peak**	
	Vehicles	**Time**	**Saturation flow**
	PCU	s	PCU/hour
1			#DIV/0!
2			#DIV/0!
3			#DIV/0!
4			#DIV/0!

SATURATION FLOW MEASUREMENT			
Junction : Victoria Rd Node A			
Link :	Victoria Rd SB left turn link 4		
Enumerator : DZ		**Time & Date : 23/07/13 AM Peak**	
	Vehicles	**Time**	**Saturation flow**
	PCU	s	PCU/hour
1			#DIV/0!
2			#DIV/0!
3			#DIV/0!
4			#DIV/0!

SATURATION FLOW MEASUREMENT			
Junction : Victoria Rd/Wales Fm Rd Node C			
Link :	Victoria Rd SB link 1		
Enumerator : DZ		**Time & Date : 23/07/13 AM Peak**	
	Vehicles	**Time**	**Saturation flow**
	PCU	s	PCU/hour
1	8	14.4	2000
2	8	14.5	1986
3	5	8.9	2022
4	12	19	2274
5	4	8	1800
6	9.5	19	1800
7	6	12.1	1785
8	6.5	10.6	2208
9	6	14.2	1521
10	7	11.8	2136
		Average Sat	**1953**

SATURATION FLOW MEASUREMENT			
Junction : Victoria Rd/Wales Fm Rd Node C			
Link :	Wales Farm Rd NB link 2		
Enumerator : DZ		**Time & Date : 23/07/13 AM Peak**	
	Vehicles	**Time**	**Saturation flow**
	PCU	s	PCU/hour
1	5	7.2	2500
2	6.5	8.7	2690
3	5	8.7	2069
4	7	12.1	2083
5	5	7.4	2432
6			#DIV/0!
7			#DIV/0!
8			#DIV/0!
9			#DIV/0!
10			
		Average Sat	**2355**



SATURATION FLOW MEASUREMENT			
Junction : Victoria Rd/Wales Fm Rd Node C			
Link :	Victoria Rd EB link 3		
Enumerator : DZ		**Time & Date : 23/07/13 AM Peak**	
	Vehicles	**Time**	**Saturation flow**
	PCU	s	PCU/hour
1	4	7.1	2028
2	5	8.5	2118
3	5	10.7	1682
4	4	5.9	2441
5	4.5	9.1	1780
6	4	5.4	2667
7	4	7	2057
8	4	7.2	2000
9			#DIV/0!
10			#DIV/0!
11			
		Average Sat	**2097**

SATURATION FLOW MEASUREMENT			
Junction : Victoria Rd/Wales Fm Rd Node C			
Link :			
Enumerator : DZ		**Time & Date : 23/07/13 AM Peak**	
	Vehicles	**Time**	**Saturation flow**
	PCU	s	PCU/hour
1			#DIV/0!
2			#DIV/0!
3			#DIV/0!
4			#DIV/0!
5			#DIV/0!
6			#DIV/0!
7			#DIV/0!
8			#DIV/0!
9			#DIV/0!
10			
		Average Sat	**#DIV/0!**

SATURATION FLOW MEASUREMENT

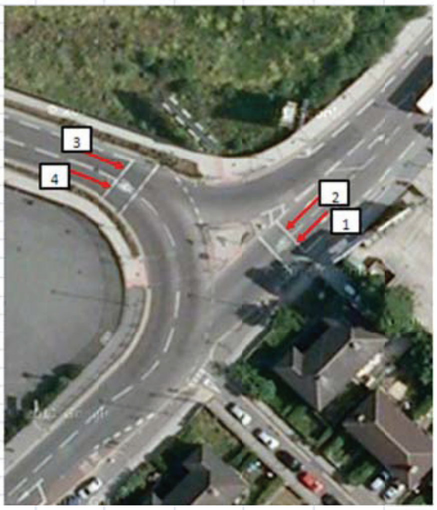
Junction : Victoria Rd Node D
Link : Wales Farm Rd SB ahead link 1
Enumerator : DZ — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	7.5	15.69	1721
2	6	10.75	2009
3	10	17.9	2011
4	4.5	8.31	1949
5	6	10.12	2134
6	4	7.31	1970
7	7	13.9	1813
8	6	11.16	1935
9	6.5	12.32	1899
10	8	17.91	1608
		Average Sat	1905

SATURATION FLOW MEASUREMENT

Junction : Victoria Rd Node D
Link : Wales Farm Rd SB ahead link 2
Enumerator : DZ — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1			#DIV/0!
2			#DIV/0!
3			#DIV/0!
4			#DIV/0!
5			#DIV/0!
6			#DIV/0!
7			#DIV/0!
8			#DIV/0!
9			#DIV/0!
10			
		Average Sat	#DIV/0!



SATURATION FLOW MEASUREMENT

Junction : Victoria Rd Node D
Link : A4000 Right turn link 3
Enumerator : DZ — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	8	18.13	1589
2	15.5	31.09	1795
3	7	14.28	1765
4	11.5	24.4	1697
5	9.5	18.75	1824
6	7	13.06	1930
7	7.5	14.06	1920
8	6	12.98	1664
9	12	25.12	1720
10	8.5	19.02	1609
11			
		Average Sat	1751

SATURATION FLOW MEASUREMENT

Junction : Victoria Rd Node D
Link : A4000 Right turn link 4
Enumerator : DZ — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	8	16.45	1751
2	6	13.28	1627
3	7	13.53	1863
4	9.5	20.78	1646
5	6.5	14.32	1634
6	12.5	24.97	1802
7	8	17.25	1670
8	8	16.44	1752
9	6.5	14.22	1646
10	10	22.12	1627
		Average Sat	1702

SATURATION FLOW MEASUREMENT

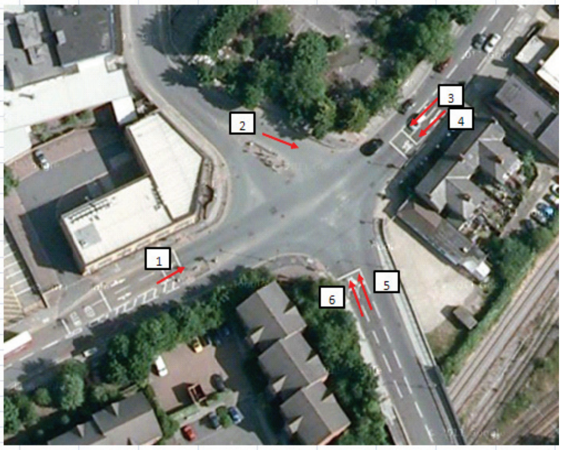
Junction : Victoria Road/OOC
Link : 1
Enumerator : BR — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	4.5	9.32	1738
2	6	12.31	1755
3	5.5	10.41	1902
4	6	10.22	2114
5	7	11.49	2193
6	5	9.56	1883
7	6	11.2	1929
8	6	10.23	2111
9	7	14.02	1797
10	6	15.2	1421
		Average Sat	1884

SATURATION FLOW MEASUREMENT

Junction :
Link : 2
Enumerator : BR — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1			#DIV/0!
2			#DIV/0!
3			#DIV/0!
4			#DIV/0!
5			#DIV/0!
6			#DIV/0!
7			#DIV/0!
8			#DIV/0!
9			#DIV/0!
10			
		Average Sat	#DIV/0!



SATURATION FLOW MEASUREMENT

Junction :
Link : 3
Enumerator : BR — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	12	21	2057
2	6	13.2	1636
3	7	13.2	1909
4	8	16.22	1776
5	10.5	20.34	1858
6	5	8.23	2187
7	6	10.01	2158
8	5	9.82	1833
9	4	7.52	1915
10	7.5	12.43	2172
11			
		Average Sat	1950

SATURATION FLOW MEASUREMENT

Junction :
Link :
Enumerator : BR — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	7	14.28	1765
2	8	16.69	1726
3	9	19.12	1695
4	5	9.22	1952
5	8	14.32	2011
6	5	11.21	1606
7	7.5	13.22	2042
8	8	14.32	2011
9	6	10.32	2093
10	5	9.2	1957
		Average Sat	1886

SATURATION FLOW MEASUREMENT

Junction :
Link : 5
Enumerator : BR — Time & Date : 23/07/13 AM Peak

	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	6	12.06	1791
2	7	13.1	1924
3	6	12.3	1756
4	4.5	9.32	1738
5	5.5	10.12	1957
6	5	8.12	2217
7	5	9.32	1931
8	6	11.42	1891
9	7	15.01	1679
10	6	12.22	1768
11			
		Average Sat	1865

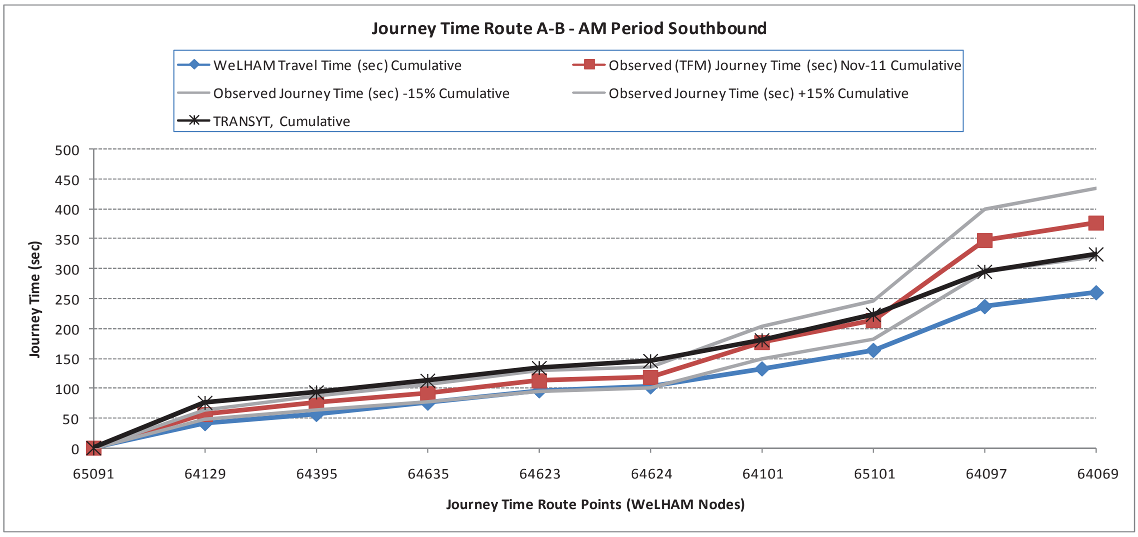
SATURATION FLOW MEASUREMENT

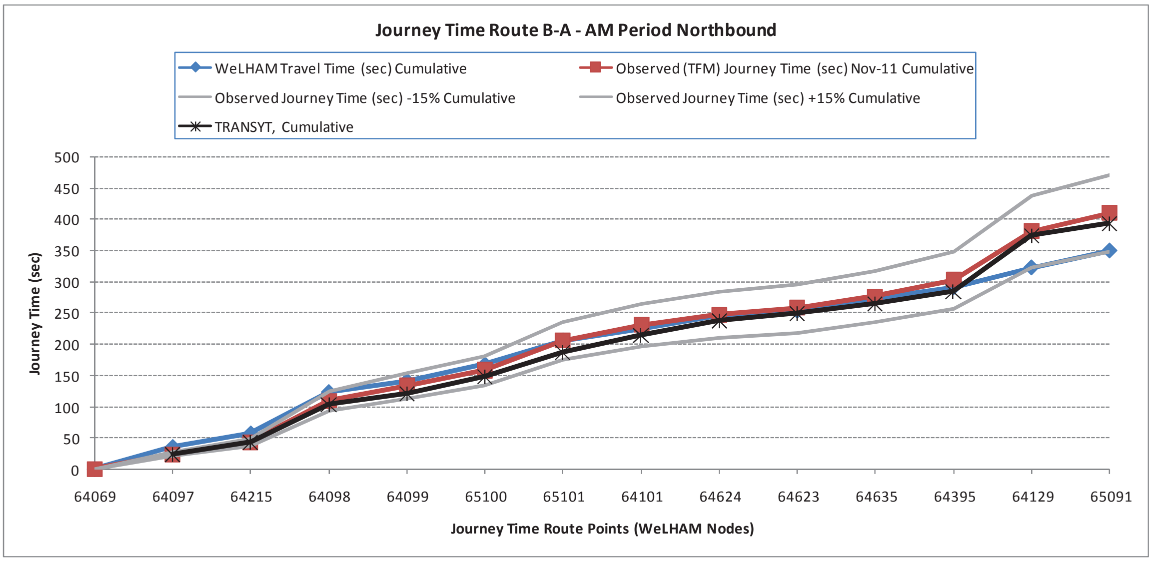
Junction :
Link : 6
Enumerator : BR — Time & Date : 23/07/13 AM Peak

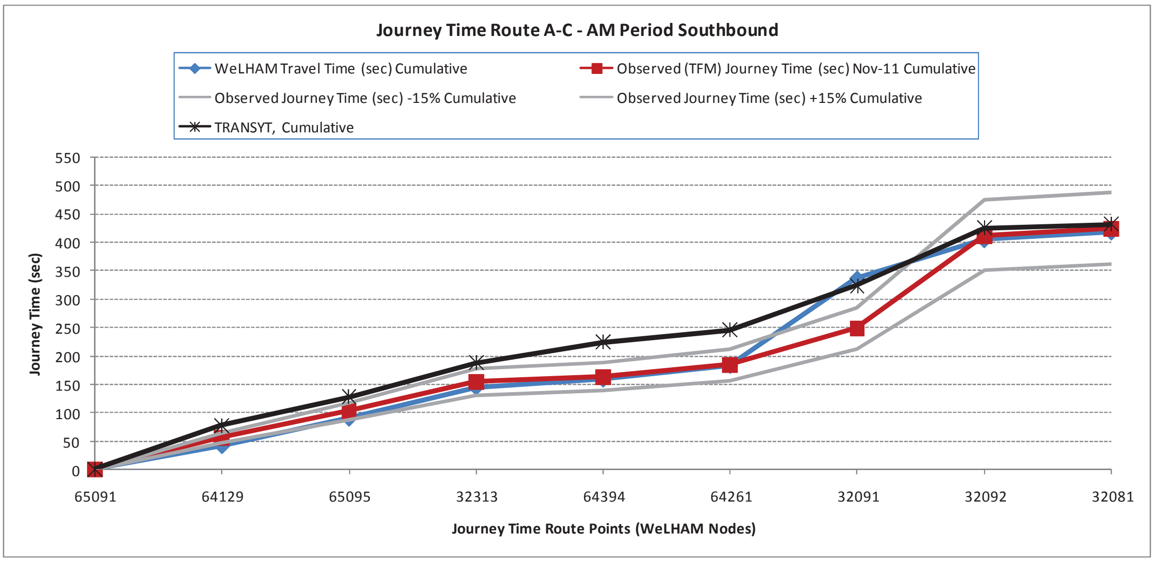
	Vehicles	Time	Saturation flow
	PCU	s	PCU/hour
1	5	9.32	1931
2	6	13.42	1610
3	4	8.32	1731
4	5	11.22	1604
5	6	12.01	1799
6			#DIV/0!
7			#DIV/0!
8			#DIV/0!
9			#DIV/0!
10			#DIV/0!
11			
		Average Sat	1735

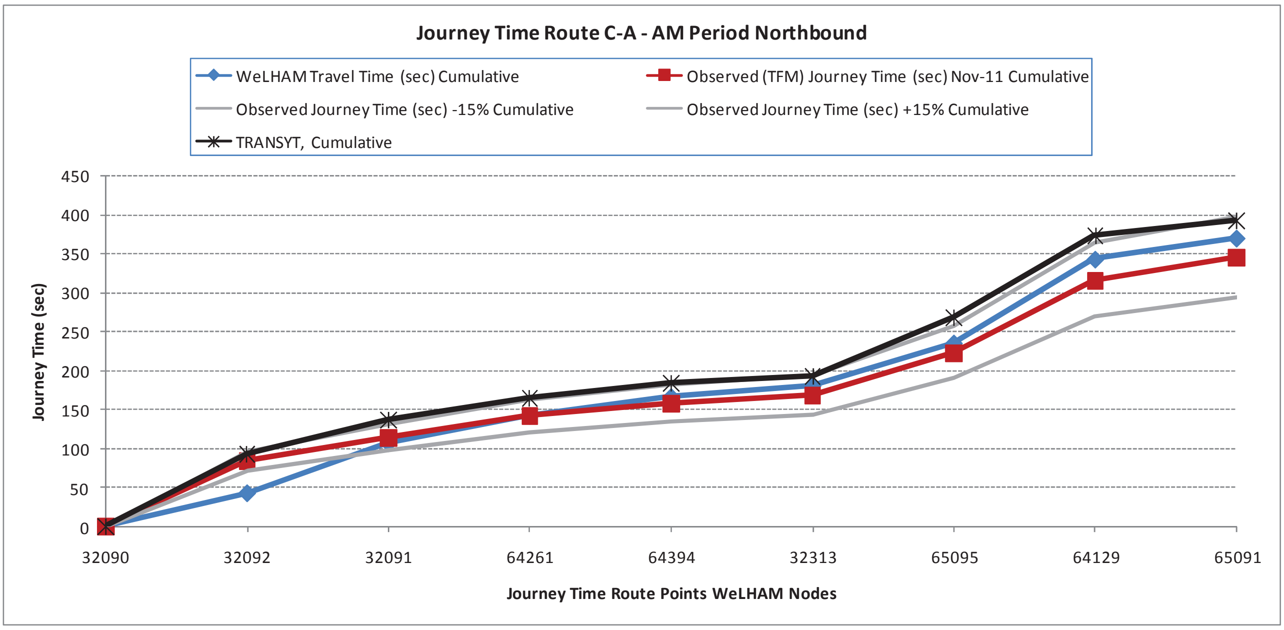
Appendix E Journey Time Graphs

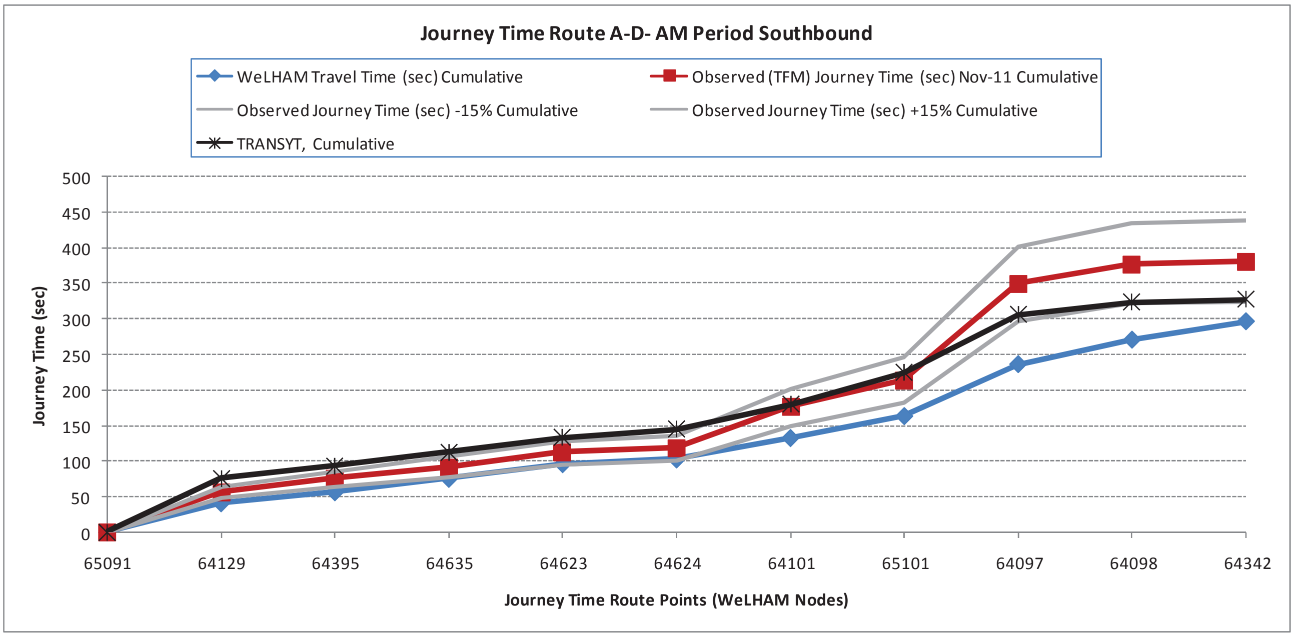
AM – OOC Study Area

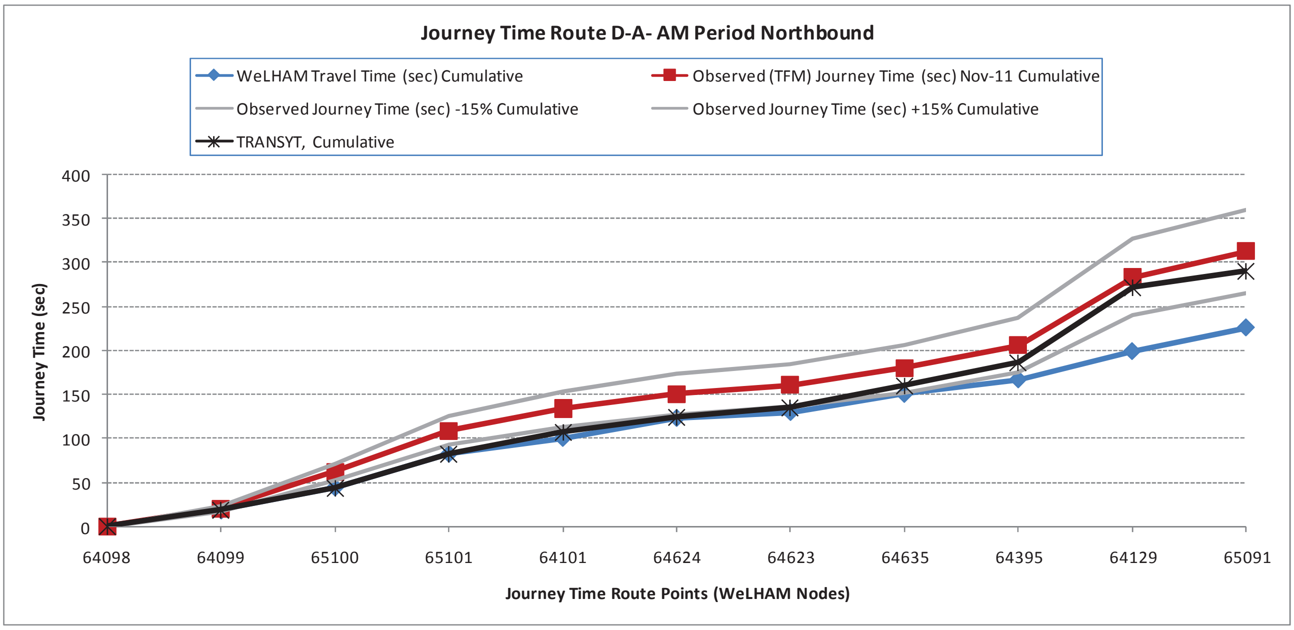


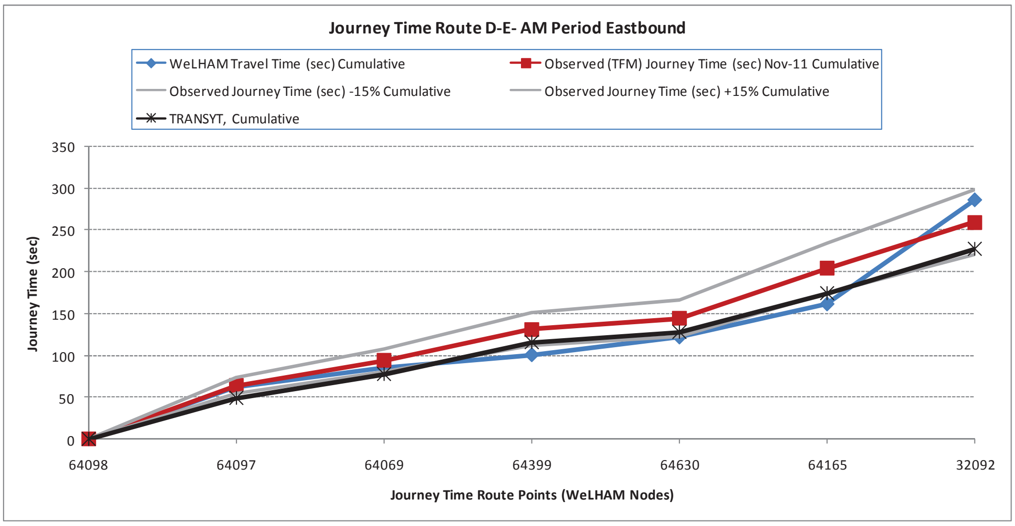



Journey Time Route A-C - AM Period Southbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
TRANSYT, Cumulative
Journey Time (sec)
550
500
450
400
350
300
250
200
150
100
50
0
65091
64129
65095
32313
64394
64261
32091
32092
32081
Journey Time Route Points (WeLHAM Nodes)


Journey Time Route C-A - AM Period Northbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
TRANSYT, Cumulative
Journey Time (sec)
0
50
100
150
200
250
300
350
400
450
32090
32092
32091
64261
64394
32313
65095
64129
65091
Journey Time Route Points WeLHAM Nodes


Journey Time Route A-D- AM Period Southbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
TRANSYT, Cumulative
Journey Time (sec)
0
50
100
150
200
250
300
350
400
450
500
65091
64129
64395
64635
64623
64624
64101
65101
64097
64098
64342
Journey Time Route Points (WeLHAM Nodes)


Journey Time Route D-A- AM Period Northbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
TRANSYT, Cumulative
Journey Time (sec)
0
50
100
150
200
250
300
350
400
64098
64099
65100
65101
64101
64624
64623
64635
64395
64129
65091
Journey Time Route Points (WeLHAM Nodes)


Journey Time Route D-E- AM Period Eastbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
TRANSYT, Cumulative
Journey Time (sec)
0
50
100
150
200
250
300
350
64098
64097
64069
64399
64630
64165
32092
Journey Time Route Points (WeLHAM Nodes)

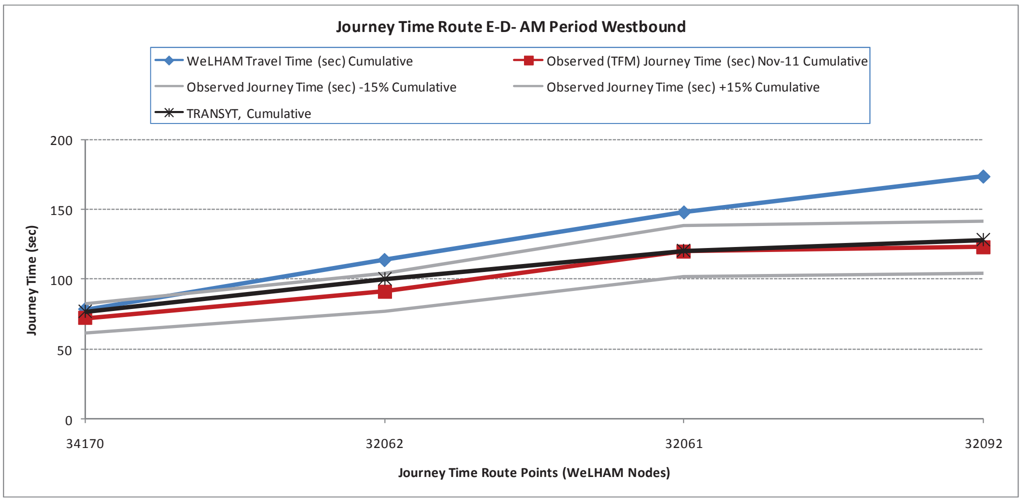
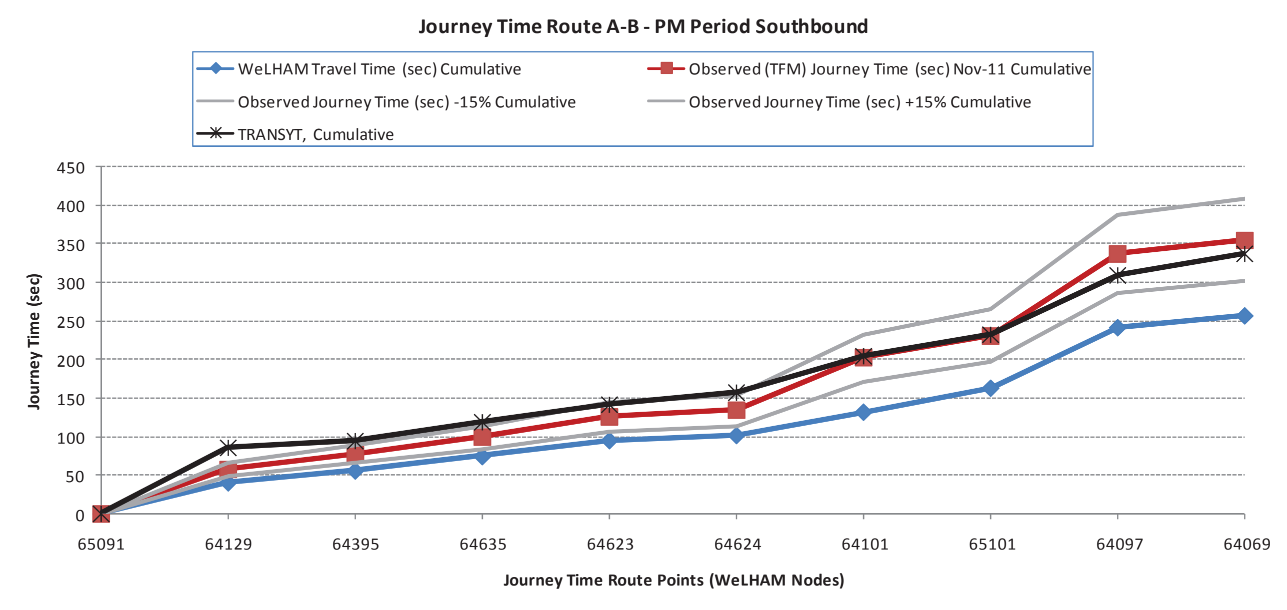
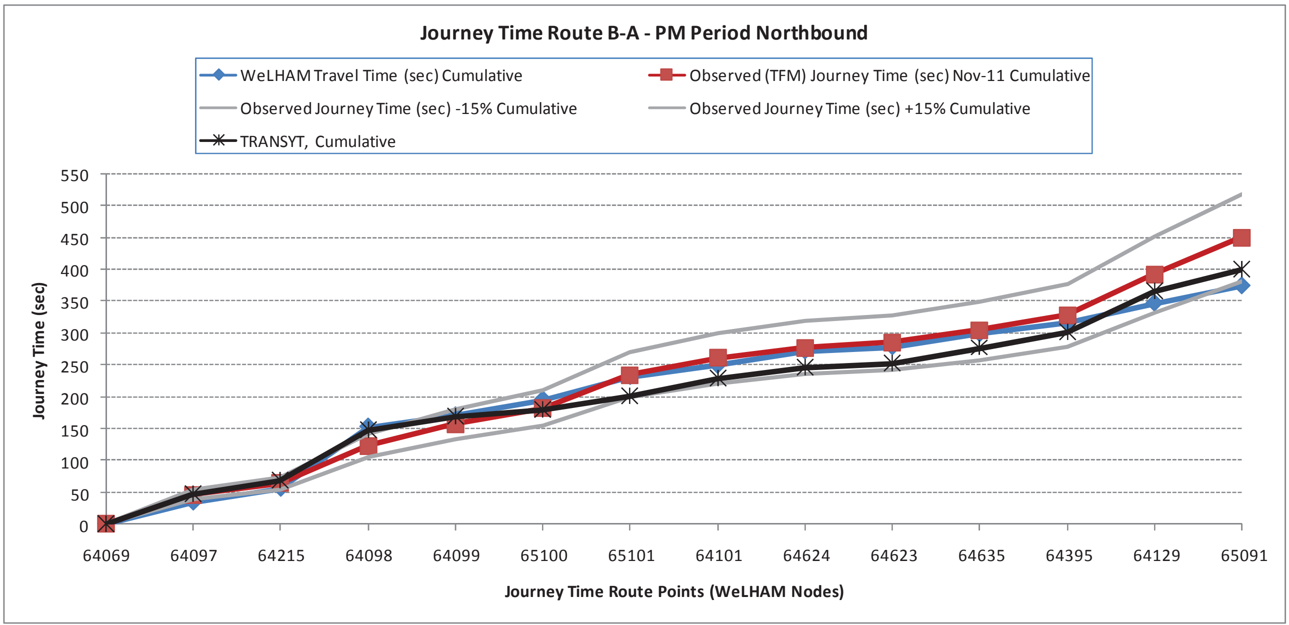
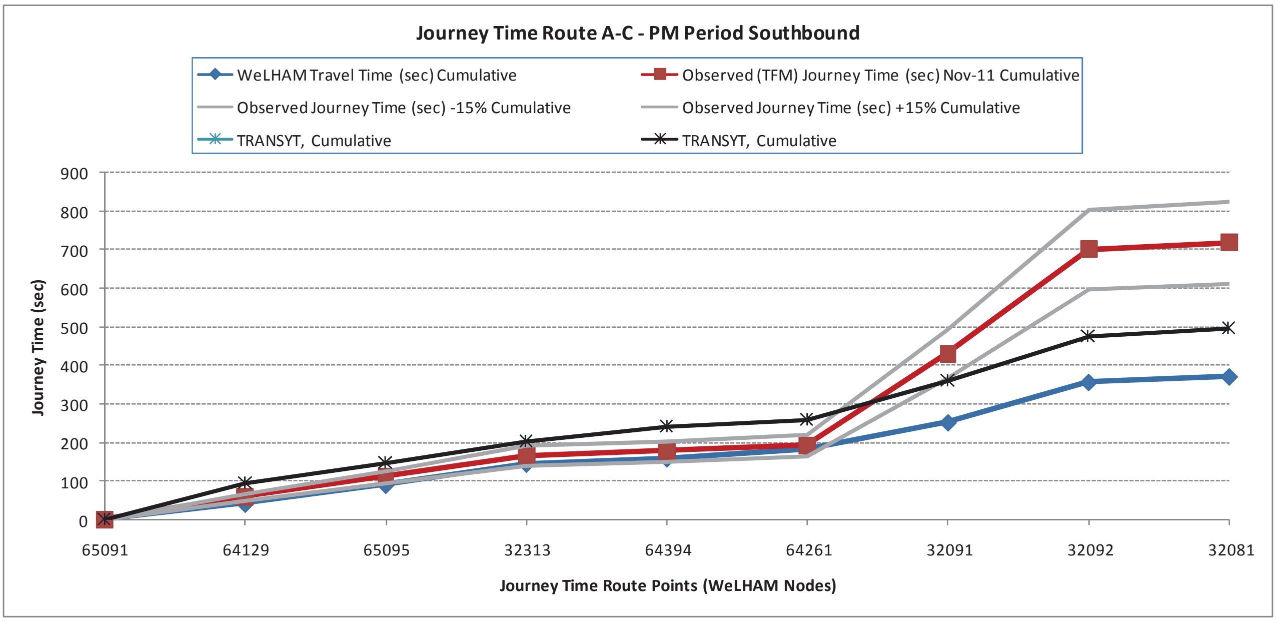

Journey Time Route E-D- AM Period Westbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
TRANSYT, Cumulative
Journey Time (sec)
0
50
100
150
200
34170
32062
32061
32092
Journey Time Route Points (WeLHAM Nodes)

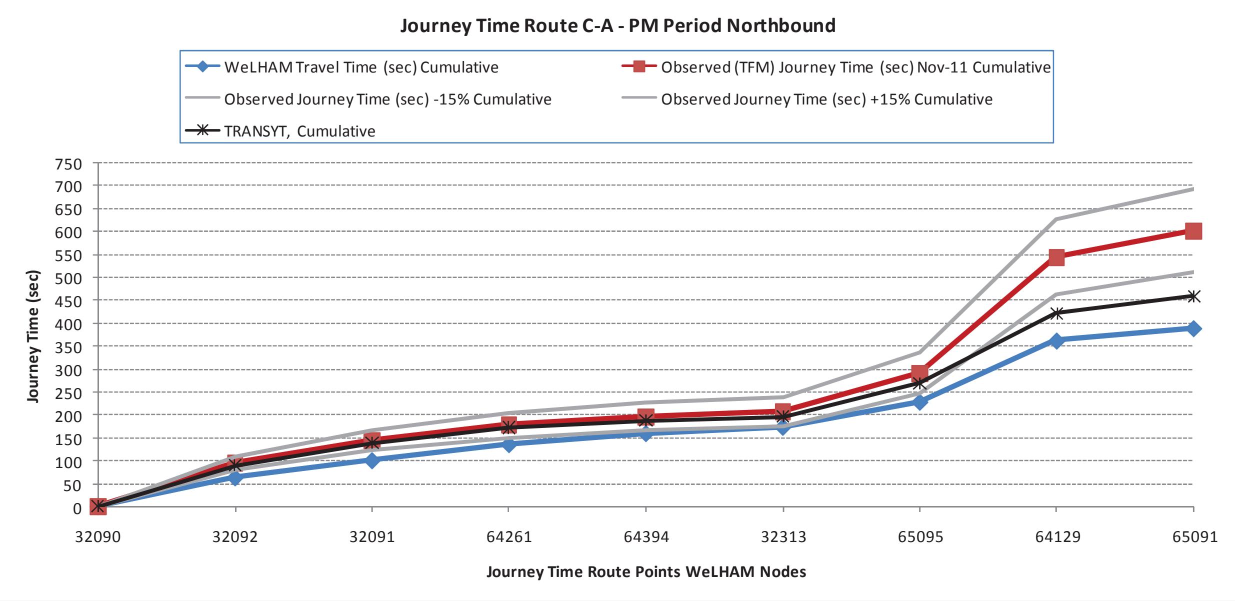
Table E 1 Old Oak Common Journey Times Comparison (2012 Base PM)

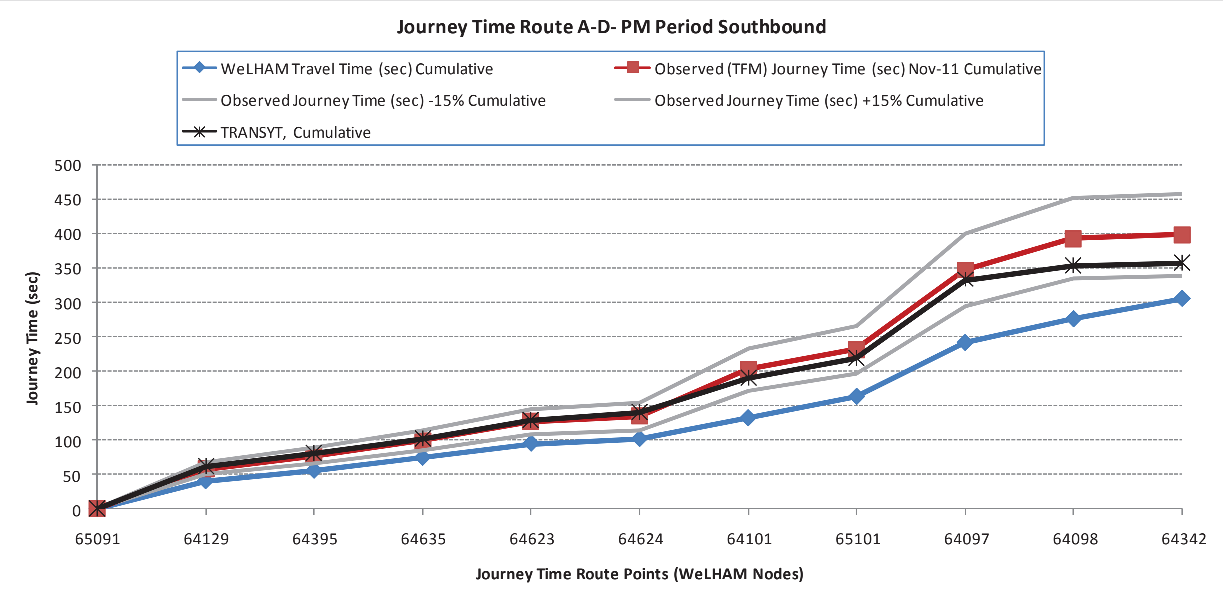
		PM 2012						
Transit points	**Direction**	**Traffic Master* Journey Time (sec)**	**SATURN**			**TRANSYT**		
			Journey Time (sec)	**Absolute Difference (sec)**	**% Difference**	**Journey Time (sec)**	**Absolute Difference (sec)**	**% Difference**
A - B	SB	302	257	45	15	315	13	4
B - A	NB	450	374	76	17	400	50	11
A - C	SB	718	370	348	48	480	238	33
C - A	NB	601	389	212	35	478	123	20
A – D	SB	398	305	93	23	358	40	10
D –A	NB	338	221	117	35	304	34	10
D - E	WB	221	175	46	21	196	25	11
E - D	EB	222	189	33	15	196	26	12
Overall		3250	2727			27280		
Note: Traffic Master and Saturn Journey time from: HS2 C221 WELHAM OOC Model Development Report Tables V1.xlsx TRANSYT journey time from: WP_224c OOC TRANSYT Journey times.xls								

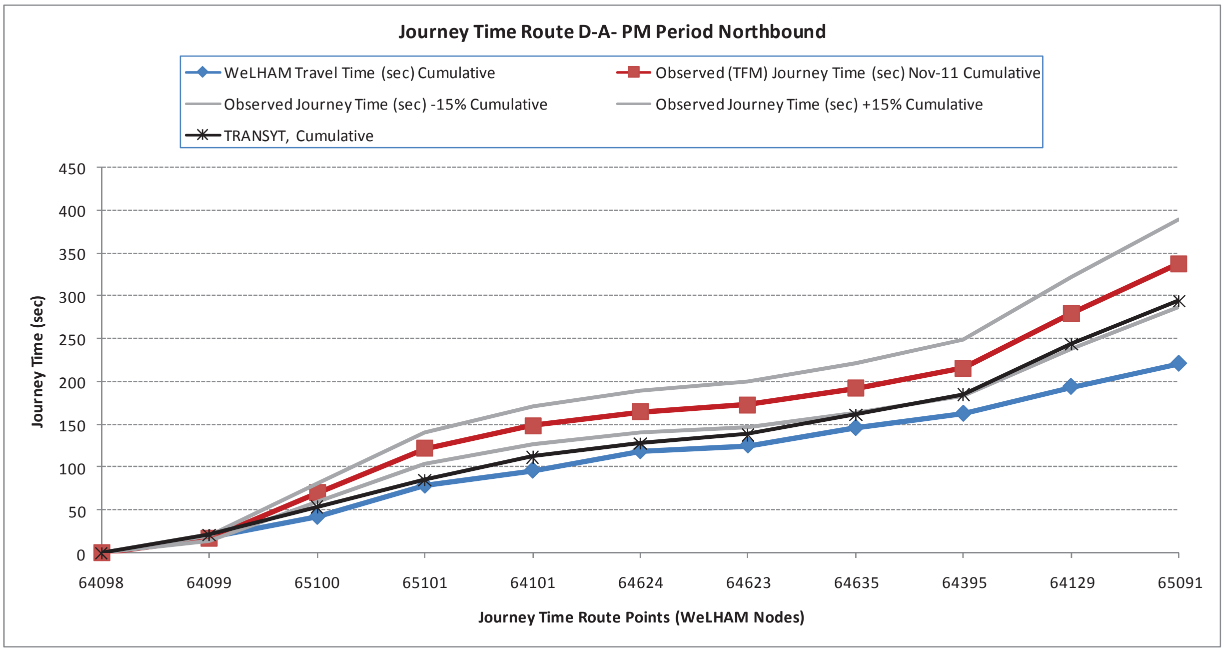

Journey Time Route A-B - PM Period Southbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
TRANSYT, Cumulative
Journey Time (sec)
450
400
350
300
250
200
150
100
50
0
65091
64129
64395
64635
64623
64624
64101
65101
64097
64069
Journey Time Route Points (WeLHAM Nodes)

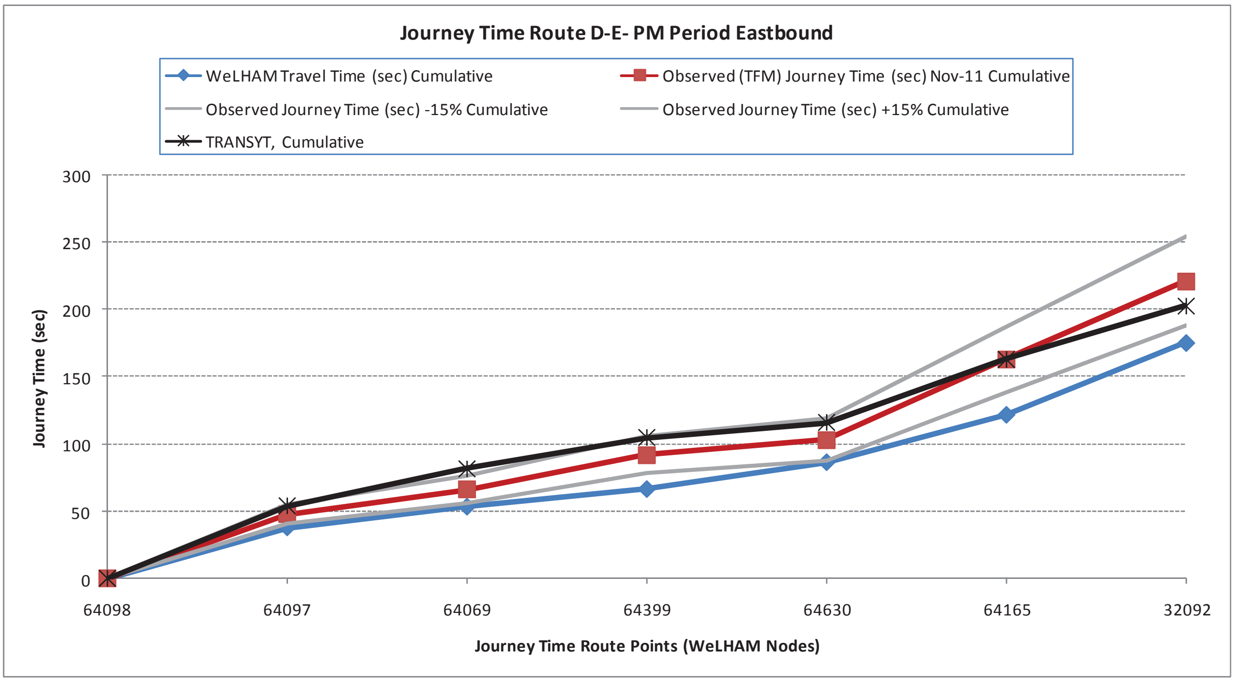

Journey Time Route B-A - PM Period Northbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
TRANSYT, Cumulative
Journey Time (sec)
550
500
450
400
350
300
250
200
150
100
50
0
64069
64097
64215
64098
64099
65100
65101
64101
64624
64623
64635
64395
64129
65091
Journey Time Route Points (WeLHAM Nodes)

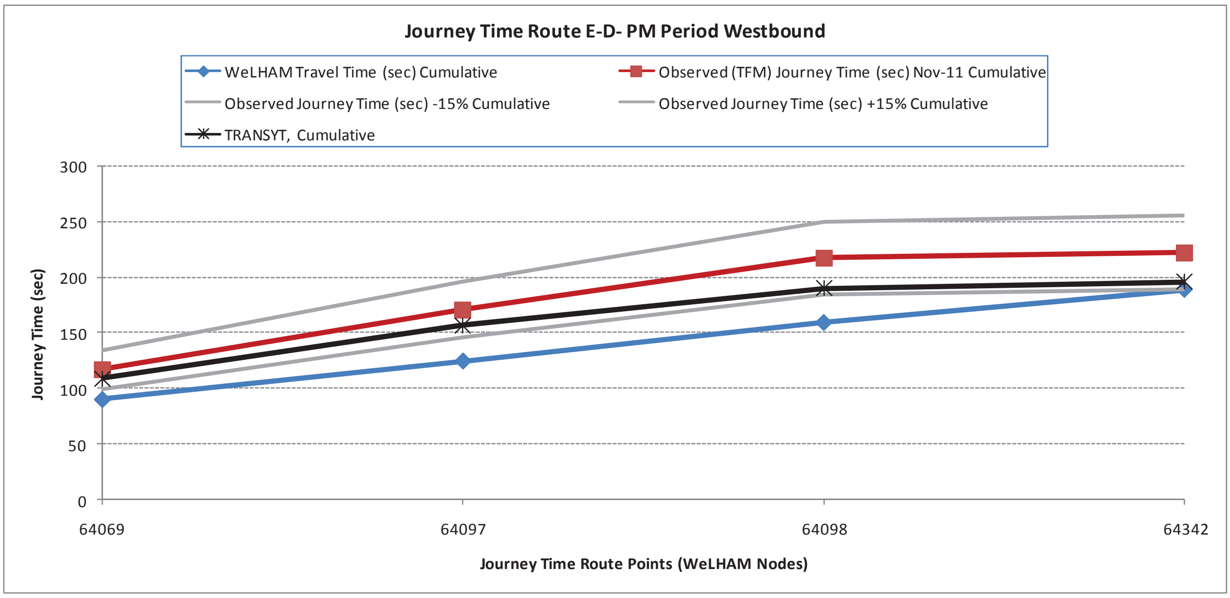

Journey Time Route A-C - PM Period Southbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
TRANSYT, Cumulative
TRANSYT, Cumulative
Journey Time (sec)
900
800
700
600
500
400
300
200
100
0
65091
64129
65095
32313
64394
64261
32091
32092
32081
Journey Time Route Points (WeLHAM Nodes)


Journey Time Route C-A - PM Period Northbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
TRANSYT, Cumulative
Journey Time (sec)
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
32090
32092
32091
64261
64394
32313
65095
64129
65091
Journey Time Route Points WeLHAM Nodes


Journey Time Route A-D- PM Period Southbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
TRANSYT, Cumulative
Journey Time (sec)
500
450
400
350
300
250
200
150
100
50
0
65091
64129
64395
64635
64623
64624
64101
65101
64097
64098
64342
Journey Time Route Points (WeLHAM Nodes)


Journey Time Route D-A- PM Period Northbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
TRANSYT, Cumulative
Journey Time (sec)
0
50
100
150
200
250
300
350
400
450
64098
64099
65100
65101
64101
64624
64623
64635
64395
64129
65091
Journey Time Route Points (WeLHAM Nodes)


Journey Time Route D-E- PM Period Eastbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
TRANSYT, Cumulative
Journey Time (sec)
300
250
200
150
100
50
0
64098
64097
64069
64399
64630
64165
32092
Journey Time Route Points (WeLHAM Nodes)


Journey Time Route E-D- PM Period Westbound
WeLHAM Travel Time (sec) Cumulative
Observed (TFM) Journey Time (sec) Nov-11 Cumulative
Observed Journey Time (sec) -15% Cumulative
Observed Journey Time (sec) +15% Cumulative
TRANSYT, Cumulative
Journey Time (sec)
300
250
200
150
100
50
0
64069
64097
64098
64342
Journey Time Route Points (WeLHAM Nodes)

Appendix F Change in Flow

Figure F 1 Change in flow at Key Locations Victoria Road/ Old Oak Common Lane(PM Peak)

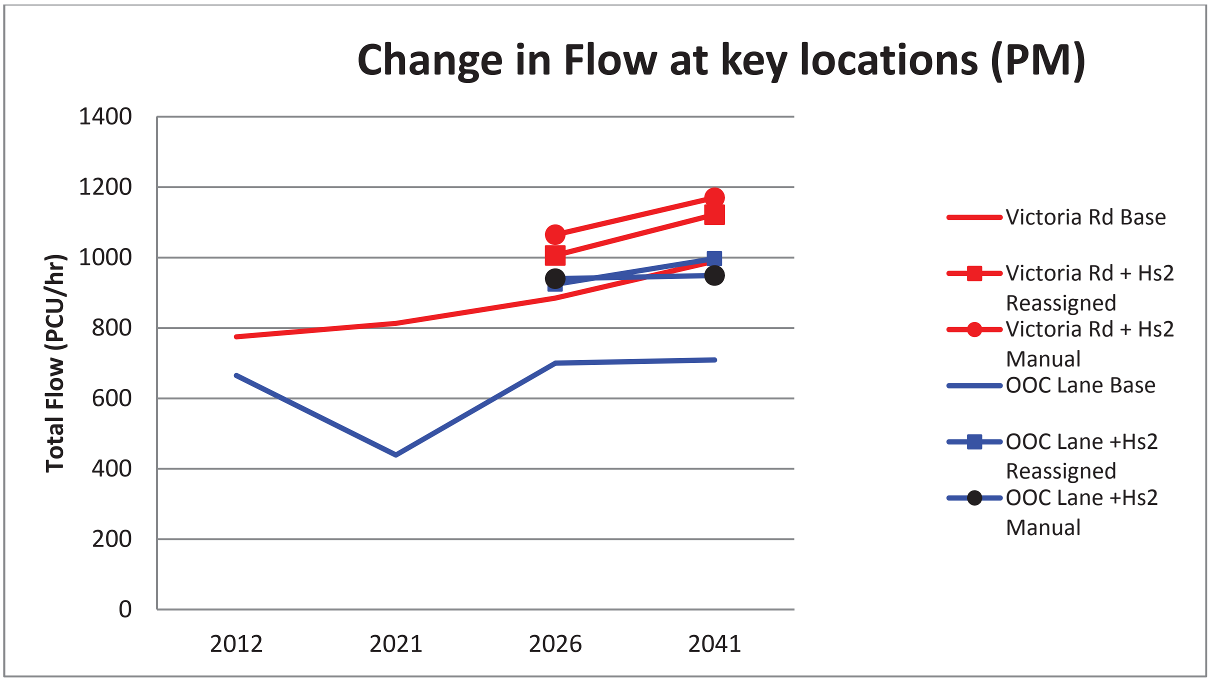
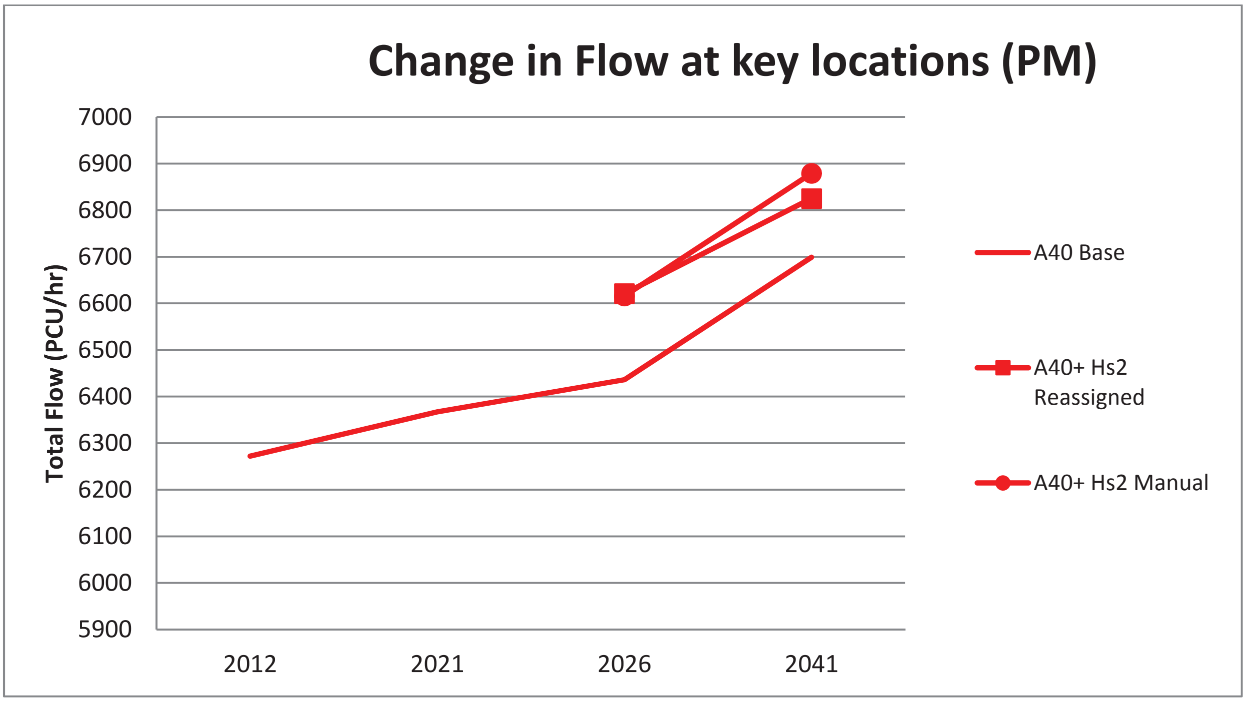


Figure F 2 Change in Flow at Key Locations A40 (PM Peak)



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Annex C(vi) – West Midlands Model Performance Reports

- **Birmingham Interchange SATURN Model Performance Technical Note**
- **Birmingham Interchange VISSIM Model Performance Report**
- **Birmingham City Centre SATURN Model Logic Check Technical Note**

1 Introduction

1.1.1 This Annex contains the model performance reports and technical notes produced for all the Community Forum Areas (CFA) in the West Midlands Metropolitan County area combined, i.e. Balsall Common and Hampton-in-Arden CFA 23; Birmingham Interchange and Chelmsley Wood CFA 24; Castle Bromwich and Bromford CFA 25; and Washwood Heath to Curzon Street CFA 26.

1.1.1 Three transport models were developed to provide forecasts of traffic flows within the study area. These models included:

- Birmingham Interchange SATURN model;
- Birmingham Interchange VISSIM model; and
- Birmingham City Centre SATURN model.

1.1.2 A brief summary of each of these models is given below and the model performance reports and technical notes are contained within this Annex.

2 West Midlands transport models

2.1 Birmingham Interchange SATURN model

2.1.1 The Birmingham Interchange SATURN model was developed to assess the effects of the introduction of a new station within the local area of the station to provide input to the Transport Assessment (TA) for HS2. The model developed provided a tool to assess specifically the implications of the proposed Interchange station on the local highway network in the forecast years of 2021 (for construction only), 2026 and 2041 (for operation) and provide estimates in the growth of demand in the local area for use in the Birmingham Interchange VISSIM model.

2.1.2 The model was developed to include variable demand modelling and to provide origin-destination growth factors to the VISSIM micro-simulation model.

2.1.3 The performance technical note outlines the development of the model and the base year validation.

2.2 Birmingham Interchange VISSIM model

2.2.1 The Birmingham Interchange VISSIM model was used to assess the impact on the highway network around Interchange station of the proposed development. The model used an existing model where the majority of the core modelling parameters and indeed local characteristics, have been incorporated within the base network. This model has been used in support of numerous planning applications and proposals for the local area, where both the local authority and the Highway Agency (HA) have accepted the model.

2.2.2 The model performance report outlines the model calibration and validation exercise for the model. The report summarises the methodology and output results,

demonstrating the models suitability for use in the assessment of future year scenarios in relation to the HS2 Interchange station.

2.3 Birmingham City Centre SATURN model

2.3.1 For Curzon Street the existing Birmingham City Centre Model (SATURN model) was utilised. The Birmingham City Centre Model (BCCM) was an established model used in the assessment of many major local developments and infrastructure projects in and around Birmingham City Centre including the assessment of the new layout of New Street station.

2.3.2 The model performance technical note outlines the update undertaken to enable the more accurate modelling of traffic movements and delays within the congested city centre around the proposed Hs2 Curzon Street station. This enhancement increased confidence in the reliability of the model forecasts by better representation of base year traffic patterns. The model was updated using junction traffic signal timings, junction layout information and bus routes and timetable information. Traffic count surveys, queue/delay surveys and journey time surveys were used to calibrate and validate the model.

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Birmingham Interchange SATURN Model Performance Technical Note

Subject HS2 Birmingham Interchange Base Model Performance Technical Note

Date 23 August 2013 Job No/Ref 224888-09

1 Introduction

To support the High Speed Rail 2 (HS2) proposals a Transport Assessment (TA) has been undertaken associated with a potential new train station close to Birmingham International Airport called Birmingham Interchange. As part of the TA, a SATURN model has been constructed and is referred to as the Birmingham Interchange Model (BIM). The aim of this note is to document the purpose, development of and the inputs into the BIM.

The note explains how the BIM model was developed from the Policy Responsive Integrated Strategy Model (PRISM) of the West Midlands and also includes details of the processes undertaken to calibrate, conduct logic checks and inform the performance review of the model.

The BIM was developed to assess the effects of the introduction of a new station within the local area of the station to provide input to the Transport Assessment for HS2. The model developed provides a tool to specifically assess the implications of the proposed Interchange Station on the local highway network in the forecast years of 2021 (for construction only), 2026 and 2041 (both of the latter for operation).

The BIM was developed as an interim model, because the updated PRISM model was not yet available. The BIM was developed to include variable demand modelling and to provide origin-destination growth factors to the VISSIM micro-simulation model for the same area. The VISSIM model will then be used for the purpose of a detailed operational assessment of the changes in travel in the local model area as a consequence of the introduction of HS2.

PRISM

PRISM is a disaggregate travel demand model developed by Mott MacDonald and RAND Europe, originally using EMME/2 and now using VISUM software. It is used for a number of applications including that of providing input to local models. The current version of the PRISM model was validated in 2006 [1]and has been used to inform Local Transport Plans and sub-regional studies. It is currently undergoing a full update (to 2012 data), but is not due to be completed until later in 2013. Therefore, for the development of the BIM SATURN model, cordon matrices and networks were taken from an interim version of PRISM that was still under development, but which nevertheless, comprised a reliable and best source of model data available at the time.

1.1 BIM Study Area

The plan below shows the study area highlighted in red by the zone boundaries. This area was cordoned from PRISM. The extent of the model covers the highway network within the area and in sufficient detail to allow for rerouting of highway trips arising from the introduction of HS2.

[1] PRISM West Midlands. PRISM 2006 Model Rebasing. Local Model Validation Report. 2009. Mott MacDonald

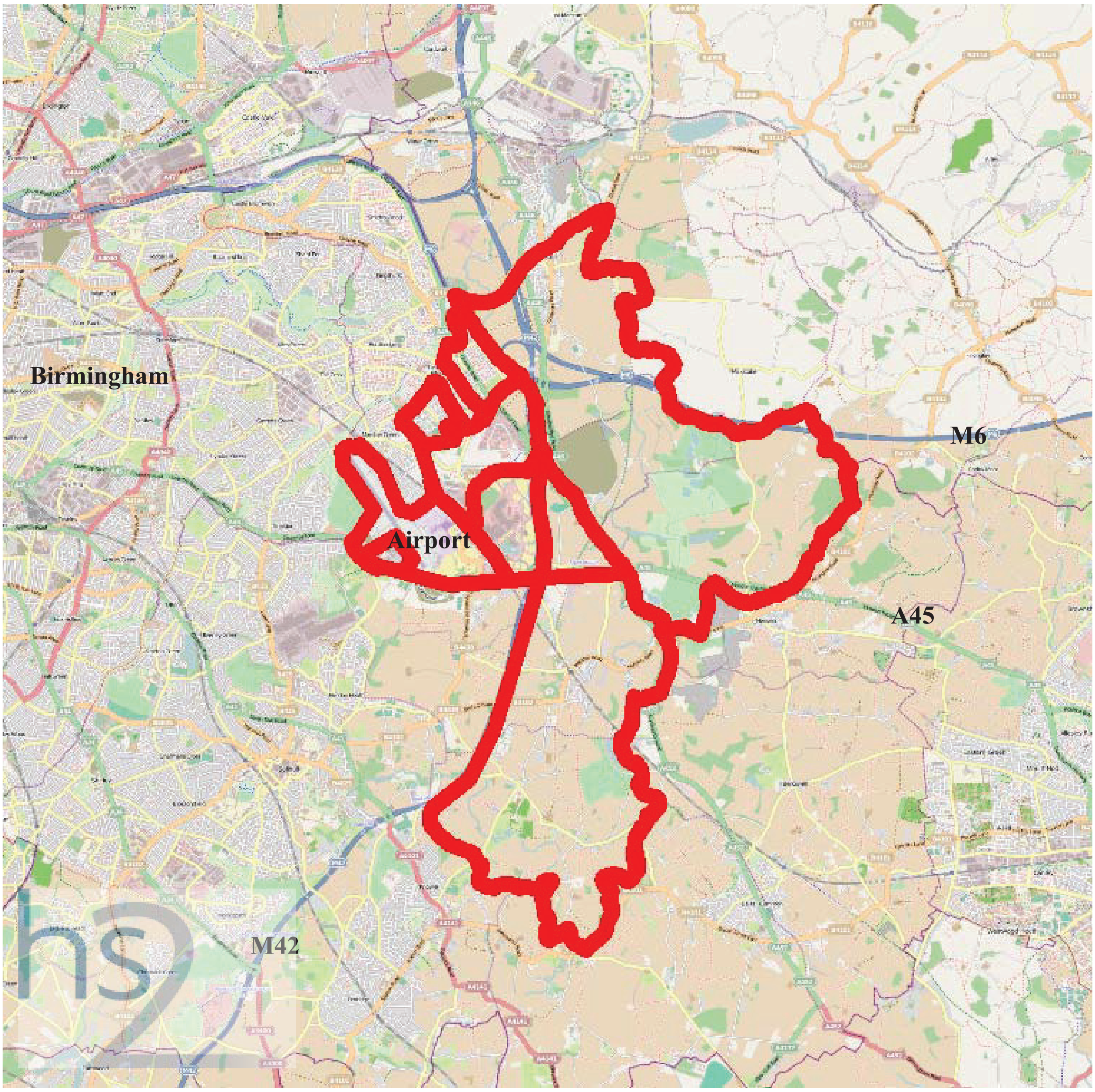

Figure 1: Birmingham Interchange Model Study Area and Zone Boundaries

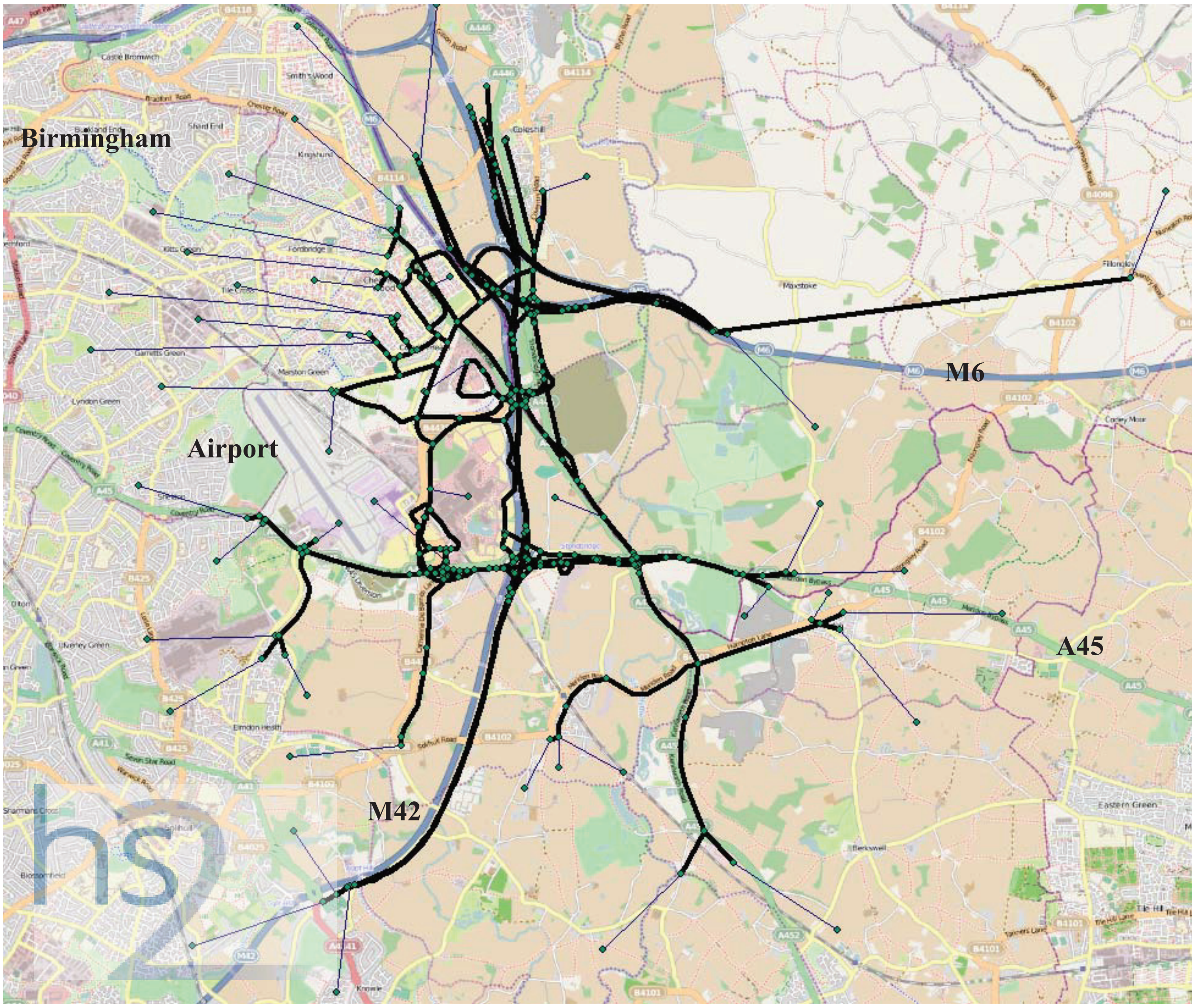

Figure 2: Model Network (Links, nodes, centroid connectors and centroids.

The study area includes the following major roads (shown in Figure 2):

- the M42 from just north of the A4141 to Birmingham Road, including junctions 6, 7 and 7a;
- the M6 including junctions 3a and 4; and
- the A45 from west of Birmingham Airport to east of the A452 Chester Road.

2 Model Development

2.1 Modelled Time Periods

Base year (2011) SATURN models were developed for the AM peak hour (08:00 to 09:00 hours), inter-peak (IP) hour (an average of 10:00 to 16:00 hours) and PM peak hour (17:00 to 18:00 hours) for a typical weekday.

2.2 Data Collection

Traffic counts were undertaken, in the local model area, in June 2012, by Arup, as part of the Transport Assessment. These counts have been used to calibrate, conduct logic checks and inform the performance review of the base year SATURN model (discussed in section 3). Highways Agency Traffic Flow Data System (TRADS) Data was used to assess the level of growth in the area between 2011 and 2012. Partly due to the slowdown in the UK economy, the difference was found to be minimal and therefore the count data was not adjusted to 2011.

2.3 PRISM Outputs

2.3.1 BIM Zones

The BIM zones (shown in Figure 1) are based on the cordoned PRISM zones. No changes were made to the PRISM zones, which are listed in Table 1. The zones which are mostly rural are larger than those in built up areas.

PRISM and SATURN Zones	Location	Description
8507	Coleshill and M6 Junction 4	Mostly rural
5212	Middle Bickenhill	Mostly rural, but will is the location of the proposed Interchange Station
5061	Hampton in Arden	Mostly rural
5066	Birmingham NEC	Car park, offices and Exhibition Centre
5065	Birmingham International Airport and Train Station	Airport, car parks, train station
5213	Birmingham Business Park	Offices, car parks.
5211	Birmingham International Airport Cargo	Hotels, car hire, warehouses.
5063	Marston Green	Residential
5052	Chelmsley Wood	Residential

Table 1: BIM Internal Zones

BIM also has 41 external zones, which represent the rest of Britain and were developed from amalgamated PRISM zones.

2.3.2 BIM Network

The SATURN network was developed from PRISM, via Geographical Information System (GIS) shapefiles. The PRISM model provided details including link distances and speeds and node and zone centroid coordinates. This skeleton network was then converted into SATURN simulation coding within the local model area.

The entire model, except the external feeder links, has been coded as simulation network. Standard saturation capacities were used for turning movements at all nodes.

Feeder link lengths were determined using the average trip length to and from each zone from the PRISM model. These distances were adjusted to minimise the impact of exceptionally long trips.

2.3.3 Matrices

The 2011 base year matrices for the AM, inter-peak (IP) and PM were derived from cordon matrices from the PRISM model. Trips to and from zones outside of the cordon area were assigned to our matrix at the external nodes.

The six user classes included in the PRISM model were retained, these are:

- HGV
- LGV
- Car other
- Car education
- Car business
- Car commute

3 Model Calibration and Performance Review

A calibration process was required to improve the level of validation and included network checks, select link factoring and matrix estimation. The calibration and performance review counts were collected in June 2012 for the HS2 Transport Assessment. Both link and turning flows were used during calibration. As required by guidance, matrix estimation utilised an independent set of traffic counts from the validation process.

Model convergence is measured by the ‘delta’ statistic, to determine how stable the model is and therefore indicates the robustness of the results. DMRB recommends a delta of less than 0.1%.

3.1 Performance Criteria

The performance review was based on DMRB flow and GEH goodness of fit guidance (between modelled and observed) from the Design Manual for Roads and Bridges (DMRB)[2] and WebTAG Unit 3.19[3].

DMRB GEH = *square root (((Modelled flow - Observed Flow)^2)/((Modelled flow + Observed Flow)/2))*

DMRB flow criteria:

- *Individual flow within 15% for flows of between 700 to 2700 vehicles per hour (vph)*
- *Individual flows within 100 vph for flows < 700 vph*
- *Individual flows within 400 vph for flows >2,700 vph*

A GEH of less than 5 is considered to be an acceptable goodness of fit. More than 85% of links are expected to pass the DMRB flow and GEH criteria.

WebTAG guidance recommends reviewing the performance of a model along screenlines, which include all roads along a cross section through the model. DMRB advises that all or nearly all screenlines should have a GEH of less than 4 or a difference of 5% or less between modelled and observed flows.

[2] DMRB (1996). Traffic Appraisal of Roads Schemes. Section 2 Traffic Appraisal Advice.
[3] Department for Transport (2012). TAG Unit 3.19. Highway Assignment Modelling.

Journey time validation has not been carried out, because the SATURN model was only an interim model used purely to generate the demand volumes necessary for detailed analysis carried out using VISSIM.

3.2 Performance Results

3.2.1 Link Flow and Convergence Results

The performance review network links were chosen to represent the movements on the main routes through the model. The performance and the logic check results are summarised in Table 2 below and included in more detail in Appendix A.

Guidance		AM Peak	Inter Peak	PM Peak
DMRB	Flow	78%	78%	83%
	GEH <5	78%	83%	78%
Convergence (delta)		0.01%	0.06%	0.05%

Table 2: BIM Performance Check Links Satisfying DMRB Guidance

The results in Table 2 show that the DMRB flow and GEH guidance is met by the following percentage of performance review links:

- 78% of links during the AM;
- 78 and 83% during the IP; and
- 83 and 78% respectively during the PM.

The model convergence was at or below 0.1%; which meets the DMRB criteria and shows that the model is stable.

Whilst not fully meeting the full requirements of WebTAG, it is considered that a sufficiently robust performance has been achieved and suitable for the ultimate purpose of contributing to the TA assessments and providing demand volumes for VISSIM modelling.

3.2.2 Screenline Results

The screenlines used for the BIM model include the following survey count locations (shown in Figure 3):

Northern Screenline:

- Stonebridge Road (A446)
- M42 between Junction 6 and 7
- Chester Road
- Coleshill Heath Road (north of Bickenhill Road)

Southern Screenline:

- M42 between Junction 6 and 7

- Bickenhill Parkway (B4438)
- Chester Road (A452, north of A45)

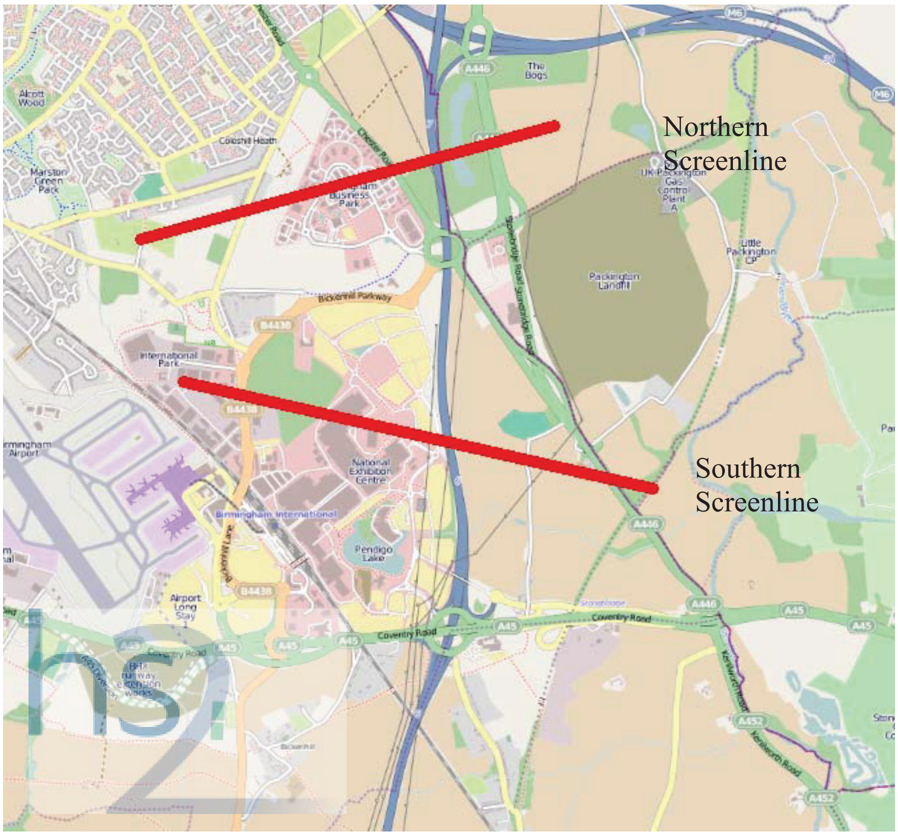

Figure 3: Screenline locations

The results (Table 3) show that the modelled screenline counts are all within 10% of the observed count data and often much closer. Overall there is a good level of fit. There are only two instances where the GEH is much higher than 4.

Screenlines	Direction	% difference between observed and modelled		
		AM	IP	PM
North	NB	0%	5%	0%
	SB	-3%	9%	7%
South	NB	-7%	1%	-4%
	SB	4%	3%	-2%
Total		-2%	4%	0%

Table 3: Screenline Results (% difference)

Screenlines	Direction	DMRB GEH		
		AM	IP	PM
North	NB	0.4	4.0	0.2
	SB	3.1	6.9	3.9
South	NB	6.7	0.4	3.7
	SB	3.5	2.6	4.1
Total		**3.1**	**6.9**	**2.1**

Table 4: Screenline Results (DMRB GEH)

4 Summary

This note summarises the approach followed and data used to develop and conduct calibration and logic checks on the SATURN BIM. The model was developed using the PRISM network and matrices and adjustments were made to enhance the level of validation.

The logic check and performance review exercise shows that 78% or more of the links meet DMRB guidance. The screenline results either satisfy or are acceptably close to guidance. The model convergence is good and well within the DMRB guidance.

Therefore, the base SATURN BIM is considered to provide a sufficiently robust base to be used to assess the highway implications of the introduction of the HS2 Interchange Station.

Appendix A: Performance Review Counts

Ref	ATC Location	Direction	Date of Survey
B50	A45 between Catherine De Barnes Lane and Junction 6 , Att - Armco, OSGR: SP 19310 83019	East	Tue, 12 June 2012
B50	A45 between Catherine De Barnes Lane and Junction 6 , Att - Armco, OSGR: SP 19310 83019	West	Tue, 12 June 2012
B51A	A45 between Junction 6 and Stonebridge Island, Att - armco, OSGR: SP 20503 83136	East	Tue, 12 June 2012
B51B	A45, Att - armco, OSGR: SP 20503 83136	West	Tue, 12 June 2012
B52	A452 Chester Road north of Stonebridge Island, Att - armco, OSGR: SP 21046 83576	North	Mon, 11 June 2012
B52	A452 Chester Road north of Stonebridge Island, Att - armco, OSGR: SP 21046 83576	South	Mon, 11 June 2012
B53	Bickenhill Road, Att - TP, OSGR: SP 18234 85011	East	Mon, 11 June 2012
B53	Bickenhill Road, Att - TP, OSGR: SP 18234 85011	West	Mon, 11 June 2012
B76	Coleshill Heath Road between Coleshill Road and Bickenhill Road, Att - tp, OSGR: SP 18592 85539	North	Mon, 11 June 2012
B76	Coleshill Heath Road between Coleshill Road and Bickenhill Road, Att - tp, OSGR: SP 18592 85539	South	Mon, 11 June 2012
B77A	Stonbridge Road, WSP - Armco, OSGR: SP 20005 86207	North	Thu, 14 June 2012
B77B	Stonebridge Road, Att - armco, OSGR: SP 20040 86201	South	Mon, 11 June 2012
B78	Chester Road, Att - armco, OSGR: SP 20040 86201	North	Tue, 12 June 2012
B78	Chester Road, Att - armco, OSGR: SP 20040 86201	South	Tue, 12 June 2012
B86	Bickenhill Parkway, Att - one way sign, OSGR: SP 18591 84386	North	Mon, 11 June 2012
B86	Bickenhill Parkway, Att - one way sign, OSGR: SP 18591 84386	South	Mon, 11 June 2012
506	M42 Northbound between J6 and J7	North	June 2012
561	M42 Southbound between J7 and J6	South	June 2012

Table A1: Performance Review Count Locations

Count Ref	Flows PCUs		GEH	% Difference	DMRB Guidance	
	Observed	Modelled			Flow	GEH
B50	2276	2088	4	-8%	✓	✓
B50	2879	2819	1	-2%	✓	✓
B51A	2378	2501	2	5%	✓	✓
B51B	2056	2154	2	5%	✓	✓
B52	1707	1508	5	-12%	✓	✓
B52	1762	1893	3	7%	✓	✓
B53	261	203	4	-22%	✓	✓
B53	180	188	1	4%	✓	✓
B76	427	434	0	2%	✓	✓
B76	334	472	7	41%	X	X
B77A	1224	925	9	-24%	X	X
B77B	1829	1625	5	-11%	✓	✓
B78	538	1049	18	95%	X	X
B78	1244	1355	3	9%	✓	✓
B86	1036	881	5	-15%	✓	✓
B86	812	1408	18	73%	X	X
506	5814	5558	3	-4%	✓	✓
561	7584	7217	4	-5%	✓	✓

Table A2: AM performance review link results

Count Ref	Flows PCUs		GEH	% Difference	DMRB Guidance	
	Observed	Modelled			Flow	GEH
B50	2779	2683	2	-3%	✓	✓
B50	2651	2563	2	-3%	✓	✓
B51A	2065	2313	5	12%	✓	X
B51B	2345	2253	2	-4%	✓	✓
B52	1480	1530	1	3%	✓	✓
B52	1718	1609	3	-6%	✓	✓
B53	181	556	20	208%	X	X
B53	309	273	2	-12%	✓	✓
B76	577	527	2	-9%	✓	✓
B76	232	685	21	196%	X	X
B77A	1731	1941	5	12%	✓	✓
B77B	1210	1258	1	4%	✓	✓
B78	1074	1121	1	4%	✓	✓
B78	607	619	0	2%	✓	✓
B86	1016	836	6	-18%	X	X
B86	836	745	3	-11%	✓	✓
506	7133	6903	3	-3%	✓	✓
561	5628	5464	2	-3%	✓	✓

Table A3: PM performance review link results

Count Ref	Flows PCUs		GEH	% Difference	DMRB Guidance	
	Observed	Modelled			Flow	GEH
B50	1976	2067	2	5%	✓	✓
B50	2008	1860	3	-7%	✓	✓
B51A	1405	1563	4	11%	✓	✓
B51B	1503	1682	4	12%	✓	✓
B52	1130	1122	0	-1%	✓	✓
B52	1228	1412	5	15%	✓	✓
B53	153	227	5	48%	✓	✓
B53	173	146	2	-15%	✓	✓
B76	320	422	5	32%	X	✓
B76	196	340	9	73%	X	X
B77A	1113	1174	2	5%	✓	✓
B77B	992	1094	3	10%	✓	✓
B78	518	706	8	36%	X	X
B78	570	889	12	56%	X	X
B86	676	735	2	9%	✓	✓
B86	581	614	1	6%	✓	✓
506	4887	4872	0	0%	✓	✓
561	4516	4506	0	0%	✓	✓

Table A4: IP performance review link results

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Birmingham Interchange VISSIM Model Performance Report

Contents

1 Introduction

1.1 Purpose of the Report

The purpose of this report is to outline the model calibration and validation exercise for the Birmingham Airport local area network VISSIM model. The report summarises the methodology and output results, demonstrating the models suitability for use in the assessment of future year scenarios in relation to the HS2 Birmingham airport interchange.

In utilising the 2009 VISSIM model, the majority of the core modelling parameters and indeed local characteristics, have been incorporated within the base network. This model has been used in support of numerous planning applications and proposals for the local area, where both the local authority and the Highway Agency (HA) have accepted the model.

The report will also summarise the traffic survey programme which has been undertaken and present output results from the model to demonstrate the replication of existing Base 2012 conditions.

The model calibration and validation exercise has been carried out in accordance with best practice guidelines, with the Base model outputs assessed and reported in the context of DMRB validation criteria.

1.2 Study Area

The study area for the VISSIM model focuses on the strategic and local road network in the vicinity of Birmingham airport and the NEC exhibition centre. The majority of the study area is included within the original 2009 Base VISSIM model, however the network was extended north to include M6 Junction 4 and M42 Junction 7a slip road, and additional local road links around the exhibition centre, airport and train station.

The network study area for Interchange Station is shown below in Figure 1.1 and includes:

- M42 Junction 6 and motorway approaches
- M6 Junction 4 and motorway approaches
- A45 Coventry Road from west of Damson Parkway to east of Stonebridge Roundabout
- Birmingham Airport approach roads
- National Exhibition Centre and circulation routes

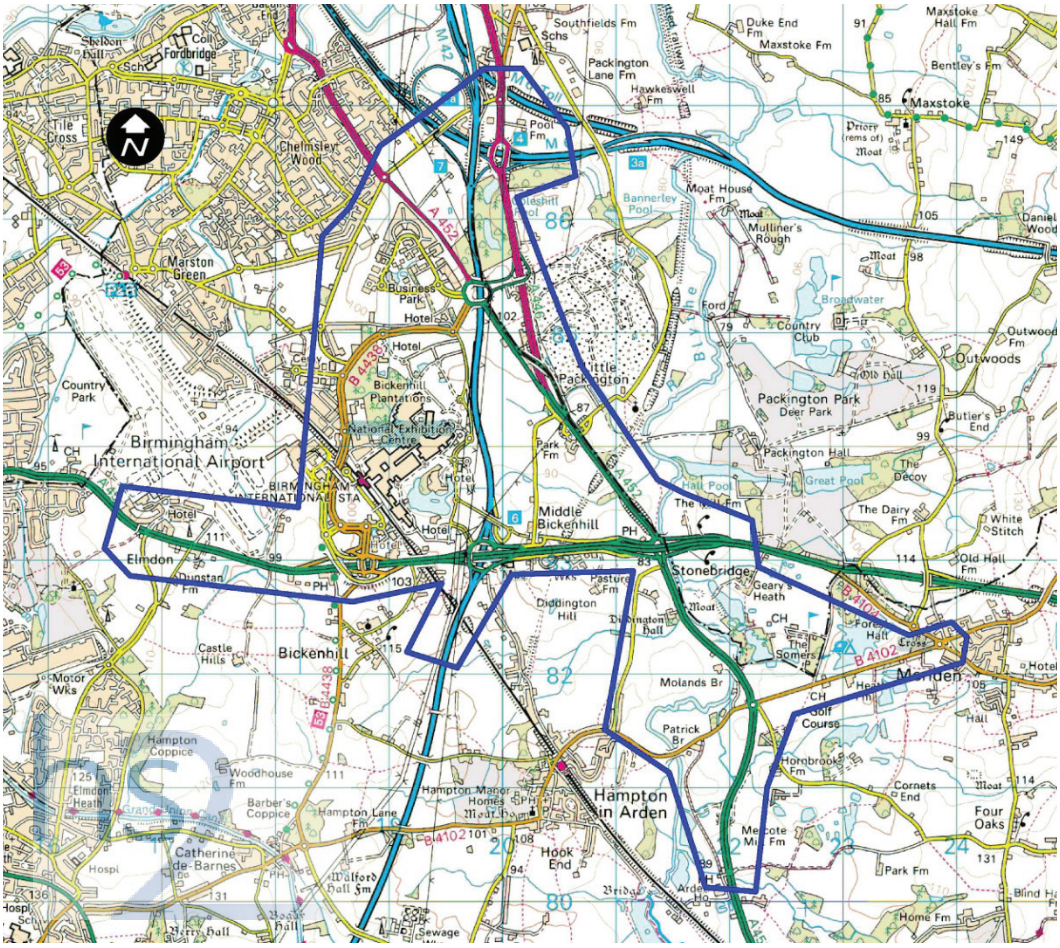


Figure 1.1 Birmingham Interchange Study Area

1.3 Report Structure

Following this introductory Chapter, this report proceeds as follows:

- Chapter 2 – 2012 Base Model Development;
- Chapter 3 – 2012 Base Model Validation; and
- Chapter 4 – Summary and Conclusions.

2 Base 2012 Model Development

2.1 Introduction

The purpose of this chapter is to summarise the process which was used to code and develop the 2012 Base model. This includes a description of the data sources used, the coding process, bus route coding, network calibration and the methodology used to develop the traffic demand matrices.

2.2 Network Development

2.2.1 Data Sources

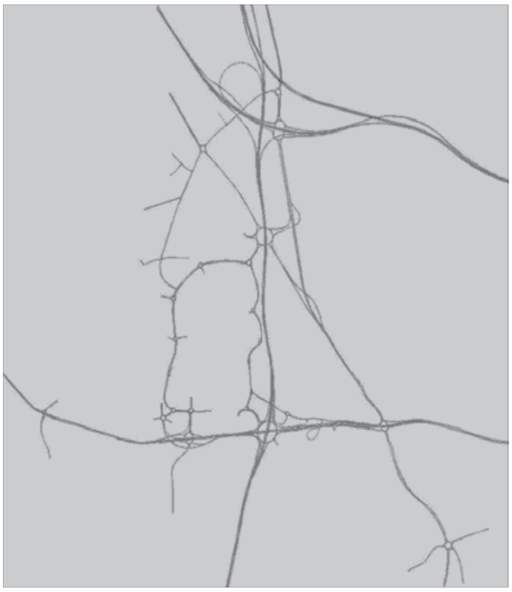
A variety of data sources were used for the development of the modelled road network, these include:

- OS Mapping – used to define the network layout;
- Traffic Survey Data – extensive survey programme carried out in 2012;
- Bus Timetables – to define the routes, stops and frequency of local services;
- Traffic Signal Data – detailed gathered during surveys.

2.2.2 Network Construction

In utilising the 2009 VISSIM model, the majority of the road network was coded previously, however the extension to the model required additional coding. The extension to the model is evident from the graphic below, which compares the 2009 and 2012 network coverage.

2009 Network



2012 Network

2.2.3 Road Network / Link Classification

Throughout the network coding process, each link was reviewed as to its appropriateness in terms of its highway classification.

The network coding also reflects the use of 'Dynamic Assignment' within VISSIM, where the link classifications, speed limits, junction coding etc all influence route choice between origin destination pairs.

The link classifications applied to the extended network replicate the 2009 model parameters, which have previously been agreed and accepted. The strategic road network has been coded using 'Freeway' link behaviour characteristics, allowing free lane selection. The majority of the local road network is developed using 'Urban' link classifications, utilising the default VISSIM parameters of lane change, gap acceptance and car following.

2.2.4 Traffic Signals

The traffic signals settings within the 2009 model have been maintained, and all new signal timings reflect on-site observations during the modelled peak periods.

2.2.5 Junction Operation

Similar to traffic signals, the accurate coding of priority junctions and their operation is also important when developing any new microsimulation model. In this context, site observations have assisted to ensure that all junction priorities accurately reflect those found across the modelled network.

The coding of roundabouts is particularly important, where gap acceptance is judged based on circulatory speeds and a clear path onto the roundabout. Within VISSIM there is a choice of 'Conflict Areas' or 'Priority Markers' to define where one vehicle gives way to the other. Conflict areas are useful for simple priority junctions, however for more complex approaches the use of priority markers provides more flexibility to represent on-site behaviour.

2.2.6 Public Transport Routes

Although buses are effectively a form of demand, as they have specific route and usually operate to a defined timetable, it is possible to define specific bus routes within the network.

2.3 Demand Matrices

Utilising the existing 2009 Base AM and PM matrices, the 2012 demands will be updated to represent the surveyed trip end totals through the method of furnessing the matrix to reassign the O/D pairs. This allows the traffic survey data on the external links to be utilised for amending the matrices, while maintaining junction turning counts, queue length and journey time survey data available for model calibration and validation purposes.

Where the network has been extended, the additional zones will again use the primary 2009 matrix as a basis from which to estimate new O/D pairs. The matrix estimation to include these additional new zones will be calibrated through the use of junction turning count survey data at select locations across the network.

2.3.1 Survey Data

An extensive survey programme has been undertaken with the objective of collating contemporary demands and network characteristics. The majority of the survey data has been used for model validation purposes, however the zone origin/destination trip end totals have been derived from the 2012 survey data to inform the furnessing of the 2012 matrices.

2.4 Trip End Total

For the purpose of demonstrating the assignment of 2012 demands, Tables 2.1 to 2.4 summarise the observed and modelled flows leaving and entering each zone. The results illustrate that the origin and destination modelled demands represent 2012 observed AM and PM peak demands.

Table 2.1 AM Base Total Traffic FROM Zones (Vehicles per Hour)

Name	Observed	Modelled	Diff	GEH
A45 Coventry Rd West of Damson P'way	1857	1857	0	0.0
Damson P'way South of A45	599	613	14	0.6
Main Rd North of A45 Junction	158	158	0	0.0
Catherine de Barnes Lane South of A45	598	596	-2	0.1
M42 South of Junction 6	5026	4955	-71	1.0
National Motorcycle Museum	18	18	0	0.0
Meriden Rd	284	322	38	2.2
A452 Kenilworth Rd	1000	1000	0	0.0
Comets End Lane	96	93	-3	0.3
Hampton Lane	316	318	2	0.1
A45 East of Stonebridge R'bt	1514	1666	152	3.8
M6 East of Junction 4	3352	3382	30	0.5
Stonebridge Rd north of Junction 4	1373	1358	-15	0.4
Solihull P'way West of Northway R'bt	110	108	-12	1.2
M42 North of Junction 4	5668	5387	-281	3.8
M6 West of Junction 4	2612	2707	95	1.8
Yorkminster Drive	131	150	19	1.6
Chester Rd West of Coleshill Heath Rd	1158	1157	-1	0.0
Chelmsley Rd	230	241	11	0.7
Coleshill Rd	363	316	-47	2.6
Bickenhill Rd	242	242	0	0.0
Starley Way	59	56	-3	0.3
Bickenhill Trading Estate	66	66	0	0.0
Morris Way	22	20	-2	0.4
Airport Way	498	453	-45	2.1
Viking Road	55	56	1	0.1
Long Stay Car Park 1	6	5	-1	0.4
Long Stay Car Park 2	8	5	-3	1.3
Station Link Rd	229	225	-4	0.3
Pendigo Way	51	49	-2	0.3
East Car Park Road	2	0	-2	2.0
Harbet Drive	89	83	-6	0.7
Perimeter Road	22	13	-9	2.2
Total	**27853**	**27727**	**-126**	**0.8**

Table 2.2 AM Base Total Traffic TO Zones (Vehicles per Hour)

Name	Observed	Modelled	Diff	GEH
A45 Coventry Rd West of Damson P'way	1626	1639	13	0.3
Damson P'way South of A45	463	457	-6	0.3
Main Rd North of A45 Junction	477	495	18	0.8
Catherine de Barnes Lane South of A45	399	438	39	1.9
M42 South of Junction 6	5304	5188	-116	1.6
National Motorcycle Museum	91	76	-15	1.6
Meriden Rd	322	280	-42	0.4
A452 Kenilworth Rd	766	795	29	1.0
Comets End Lane	213	211	-2	0.1
Hampton Lane	563	615	52	2.2
A45 East of Stonebridge R'bt	1858	1687	-172	4.1
M6 East of Junction 4	1960	2008	48	1.1
Stonebridge Rd north of Junction 4	1263	1159	-104	3.0
Solihull P'way West of Northway R'bt	1533	1396	-137	3.6
M42 North of Junction 4	4026	4003	-23	0.4
M6 West of Junction 4	3212	3287	75	1.3
Yorkminster Drive	95	96	1	0.1
Chester Rd West of Coleshill Heath Rd	826	841	15	0.5
Chelmsley Rd	219	217	-2	0.1
Coleshill Rd	323	321	-2	0.1
Bickenhill Rd	152	166	14	1.1
Starley Way	278	277	-1	0.0
Bickenhill Trading Estate	190	189	-1	0.1
Morris Way	40	46	6	1.0
Airport Way	598	597	-1	0.6
Viking Road	116	123	7	0.6
Long Stay Car Park 1	69	70	1	0.1
Long Stay Car Park 2	12	14	2	0.4
Station Link Rd	691	701	10	0.4
Pendigo Way	40	38	-2	0.3
East Car Park Road	1	0	-1	1.4
Harbet Drive	156	149	-7	0.6
Perimeter Road	214	198	-16	1.1
Total	**28115**	**27640**	**-476**	**2.8**

Table 2.3 PM Base Total Traffic FROM Zones (Vehicles per Hour)

Name	Observed	Modelled	Diff	GEH
A45 Coventry Rd West of Damson P'way	1953	1971	18	0.4
Damson P'way South of A45	632	628	-4	0.2
Main Rd North of A45 Junction	229	231	2	0.1
Catherine de Barnes Lane South of A45	443	431	-12	0.6
M42 South of Junction 6	5350	5368	18	0.2
National Motorcycle Museum	80	84	4	0.4
Meriden Rd	350	421	71	3.6
A452 Kenilworth Rd	791	907	116	4.0
Comets End Lane	136	148	12	1.0
Hampton Lane	402	422	20	1.0
A45 East of Stonebridge R'bt	2277	2331	54	1.1
M6 East of Junction 4	3245	3194	-51	0.9
Stonebridge Rd north of Junction 4	1141	1185	44	1.3
Solihull P'way West of Northway R'bt	1310	1321	11	0.3
M42 North of Junction 4	4986	5046	60	0.9
M6 West of Junction 4	2979	3016	37	0.7
Yorkminster Drive	125	142	17	1.4
Chester Rd West of Coleshill Heath Rd	706	710	4	0.2
Chelmsley Rd	173	186	13	0.9
Coleshill Rd	315	323	8	0.5
Bickenhill Rd	186	196	10	0.7
Starley Way	303	313	10	0.6
Bickenhill Trading Estate	160	165	5	0.4
Morris Way	45	46	1	0.2
Airport Way	1002	1014	12	0.4
Viking Road	241	259	18	1.1
Long Stay Car Park 1	177	193	16	1.2
Long Stay Car Park 2	22	16	-6	1.4
Station Link Rd	736	614	-122	4.7
Pendigo Way	44	46	2	0.3
East Car Park Road	0	0	0	0.0
Harbet Drive	92	88	-4	0.4
Perimeter Road	171	139	-32	2.6
Total	**30802**	**31152**	**350**	**2.0**

Table 2.4 PM Base Total Traffic TO Zones (Vehicles per Hour)

Name	Observed	Modelled	Diff	GEH
A45 Coventry Rd West of Damson P'way	2105	2158	53	1.1
Damson P'way South of A45	560	591	31	1.3
Main Rd North of A45 Junction	540	539	-1	0.0
Catherine de Barnes Lane South of A45	644	743	99	3.8
M42 South of Junction 6	5608	5576	-32	0.4
National Motorcycle Museum	8	5	-3	1.1
Meriden Rd	356	291	-65	3.6
A452 Kenilworth Rd	1118	976	-142	4.4
Comets End Lane	114	110	-4	0.4
Hampton Lane	472	462	-10	0.5
A45 East of Stonebridge R'bt	2231	2146	-86	1.8
M6 East of Junction 4	2665	2807	142	2.7
Stonebridge Rd north of Junction 4	1573	1627	54	1.4
Solihull P'way West of Northway R'bt	94	99	5	0.5
M42 North of Junction 4	5567	5373	-194	2.6
M6 West of Junction 4	3541	3537	-4	0.2
Yorkminster Drive	165	158	-7	0.1
Chester Rd West of Coleshill Heath Rd	1340	1169	-171	4.8
Chelmsley Rd	321	279	-42	2.4
Coleshill Rd	388	303	-85	4.6
Bickenhill Rd	318	274	-44	2.6
Starley Way	40	39	-1	0.2
Bickenhill Trading Estate	99	63	-36	4.0
Morris Way	32	47	15	2.4
Airport Way	781	754	-27	1.0
Viking Road	123	98	-25	2.3
Long Stay Car Park 1	56	53	-3	0.4
Long Stay Car Park 2	12	12	0	0.0
Station Link Rd	215	234	19	1.3
Pendigo Way	41	39	-2	0.4
East Car Park Road	0	4	4	2.8
Harbet Drive	101	104	3	0.3
Perimeter Road	10	10	0	0.0
Total	**31238**	**30703**	**-535**	**3.0**

2.5 Assignment Convergence

The demand matrices were assigned to the VISSIM model using dynamic assignment, with an evaluation interval set at 900 seconds (default). A minimum of 10 model runs were undertaken to establish paths and costs during each 900 second interval, with the use of the convergence evaluation output monitor during each additional run.

With reference to WebTAG, it is acknowledged that convergence of congested assignment models can be monitored using a variety of indicators, however the appropriate method is influenced by the assignment method of the model. In the case of dynamic assignment proximity indicators can be used to assess how close the current flow and costs patterns are to the assignment objective.

One of the most appropriate proximity indicators is the duality gap, which is described as a natural convergence indicator for equilibrium process, measuring how far the current flow pattern is removed from the desired equilibrium, with a target output approaching zero.

Tables 2.5 and 2.6 provide a summary of the duality gap convergence outputs from the AM and PM peak models, respectively.

Table 2.5 AM Peak Duality Gap Model Convergence Results

Time From	Time To	Model Run (difference random seed value)				
		RS10	RS20	RS30	RS40	RS50
0	900	0.00	0.00	0.00	0.00	0.00
900	1800	0.01	0.00	0.00	0.01	0.00
1800	2700	0.00	0.00	0.00	0.00	0.00
2700	3600	0.00	0.00	0.00	0.00	0.00
3600	4500	0.00	0.00	0.00	0.00	0.00
4500	5400	0.00	0.00	0.00	0.00	0.00

Table 2.6 PM Peak Duality Gap Model Convergence Results

Time From	Time To	Model Run (difference random seed value)				
		RS10	RS20	RS30	RS40	RS50
0	900	0.01	0.01	0.01	0.01	0.01
900	1800	0.01	0.01	0.01	0.01	0.01
1800	2700	0.01	0.01	0.01	0.01	0.01
2700	3600	0.01	0.01	0.01	0.01	0.01
3600	4500	0.01	0.01	0.01	0.01	0.01
4500	5400	0.01	0.01	0.01	0.01	0.01

While the duality gap results are presented to the nearest two decimal places, the results demonstrate an acceptable level of convergence with the results from each of the modelled random seed values shown to be >0.1%.

3 Base 2012 Model Validation

3.1 Introduction

Model validation is the process whereby the accuracy of the calibrated model is tested by comparing modelled flows against a set of independent data. The purpose of this Chapter is therefore to summarise the validation process and associated results.

In accordance with DMRB, a selection of independent data was 'held back' from the matrix development process to be used for validation purposes. However, due to the difficulty in obtaining two completely independent sets of survey data for the same time periods / years and at the same locations, a small number of traffic counts used in the calibration process have also be used for validation checks. This is accepted practice and it has therefore been deemed to be acceptable for the purposes of developing a suitable Base model fit for the purpose of assessing the future Pavilions development proposals.

For the purposes of validation, the operation of the VISSIM network was checked using four main data types, namely:

- Turning counts;
- Link counts;
- Screenline counts; and
- Journey time data.

All traffic flow data was compared over the relevant Weekday AM and PM peak hours and, in accordance with DMRB, was directional.

3.2 VISSIM Model Version

To ensure the accuracy of the validation results, all model runs were carried out using the same version of VISSIM as was used to develop, code and calibrate the 2009 model in the first instance. In this case, version 5.20-14 was used. Once again, this is accepted best practice and helps to ensure that the model behaves in a similar way as it did when it was first being coded.

3.3 GEH Statistic and Validation Criteria

3.3.1 GEH Statistic

The GEH statistic is a standard method of comparing modelled traffic data against an independent data set. It takes the form of the chi-squared statistic and incorporates both relative and absolute errors. It takes the following mathematical formula:

$$GEH = \sqrt{((M-C)^2 \div ((M+C) \div 2))}$$

Where: M = modelled flow

C = observed flow

The advantage of using the GEH statistic is that it indicates the 'goodness of fit' between the modelled and observed flows, thus removing the volumetric element of specific traffic flows on any particular link. For example, a difference of 500 vehicles on a link with high traffic volumes may provide a better 'fit' than a difference of 100 vehicles on a lightly trafficked link. The GEH statistic allows this variation in volumetric differences to be taken into account.

DMRB recommends that the GEH statistic is applied to individual link flows and screenline totals. It does not, however, suggest any specific statistic to use with regards turning counts. Nonetheless, it is generally accepted that the GEH statistic is an acceptable means by which to check and validate modelled turning counts against the equivalent observed data. In this regard, the acceptability criteria for the GEH statistic used throughout the following validation process is summarised below.

Table 3.1 GEH Statistic Validation Criteria and Targets (as defined by DMRB)

Turning counts	Individual flows: GEH<5	>85% of cases
Link flows	Individual flows: GEH<5	>85% of cases
Screenline counts	Individual flows: GEH<4	All (or nearly all) screenlines

3.3.2 Other Validation Criteria

DMRB also recommends that a series of other criteria / targets are used during the validation process. These criteria include:

- Percentage difference comparisons for turning counts;
- Percentage difference comparisons for link flows; and
- Percentage difference comparisons for screenlines.

The acceptability criteria and targets recommended by DMRB with regard the above are summarised in Table 3.2.

Table 3.2 Other Validation Criteria and Targets (as defined by DMRB)

Data Type	Acceptability Criteria	Target
Turning count and link flows	For flows 700-2,700vph: to be within 15%	>85% of cases
	For flows <700vph: to be within 100vph	
	For flows >2,700vph: to be within 400vph	
Total screenline flows	To be within 15%	All (or nearly all) screenlines

3.4 Turning Count Comparisons

For the purposes of comparing modelled turning counts against observed turning counts, the flows recorded at eight junctions across the modelled road network during the AM and PM peak periods. These were as follows:

- A45 / Damson Parkway;
- A45 / B4438;
- M42 Junction 6;
- A45 / A452;
- A452 / B4102;
- A452 / A446;
- M6 Junction 4; and
- Stonebridge Road / Coleshill Heath Road.

As discussed in Section 3.3, turning counts have been compared using the GEH statistic and percentage comparisons. The results of these comparisons for the Weekday AM and PM modelled hours are summarised in Tables 3.3 and 3.4, respectively.

Table 3.3 Turning Count Validation Results – Weekday AM Summary

Criteria	Target	Weekday AM Modelled Hour (08:00-09:00)
Individual flows: GEH<5	>85% of cases	89%
For flows <700vph: to be within 100vph	>85% of cases	91%
For flows 700vph-2,700vph: to be within 15%	>85% of cases	100%

Table 3.4: Turning Count Validation Results – Weekday PM Summary

Criteria	Target	Weekday PM Modelled Hour (17:00-18:00)
Individual flows: GEH<5	>85% of cases	87%
For flows <700vph: to be within 100vph	>85% of cases	96%
For flows 700vph-2,700vph: to be within 15%	>85% of cases	75%

The full list of turning count GEH statistic results for the two peak hour periods can be found in Appendix A. According to the results shown above, however, the scenarios generally meet the required turning count validation requirements. During the PM peak the turning flows between 700 and 2,700 vph were within 15% of observed in 75% of cases, this equates to 9 out of 12 results. Due to the relatively small sample size we considered the 75% results as being acceptable in this instance. Based on these results, it is therefore concluded that the Weekday AM and PM Base models are fit for purpose.

3.5 Link Flow Comparisons

For the purposes of comparing modelled link flows against the equivalent observed link flows, the turning count data was collated into individual approach flows to the key junctions.

As discussed in Section 3.3, link flows are compared using the GEH statistic and percentage comparisons. The results of these comparisons for each of the modelled time periods are summarised in Tables 3.5 and 3.6.

Table 3.5 Link Flow Validation Results – Weekday AM Summary

Criteria	Target	Weekday AM Modelled Hour (08:00-09:00)
Individual flows: GEH<5	>85% of cases	88%
For flows <700vph: to be within 100vph	>85% of cases	87%
For flows 700vph-2,700vph: to be within 15%	>85% of cases	88%

Table 3.6 Link Flow Validation Results – Weekday PM Summary

Criteria	Target	Weekday PM Modelled Hour (17:00-18:00)
Individual flows: GEH<5	>85% of cases	88%
For flows <700vph: to be within 100vph	>85% of cases	94%
For flows 700vph-2,700vph: to be within 15%	>85% of cases	87%

The above tables show that both the Weekday AM and PM peak periods satisfy the required link flow validation criteria as stipulated by DMRB in the majority of cases. It is therefore concluded that the Weekday AM and PM Base models are fit for purpose.

3.6 Screenline Validation

In addition to comparing individual link flow data, it is also good practice to define a number of screenlines throughout the modelled network and compare the combined link flow data. For this reason, 2 screenlines were defined and the necessary hourly flow data derived. Figure 3.1 illustrates the location of the screenlines.

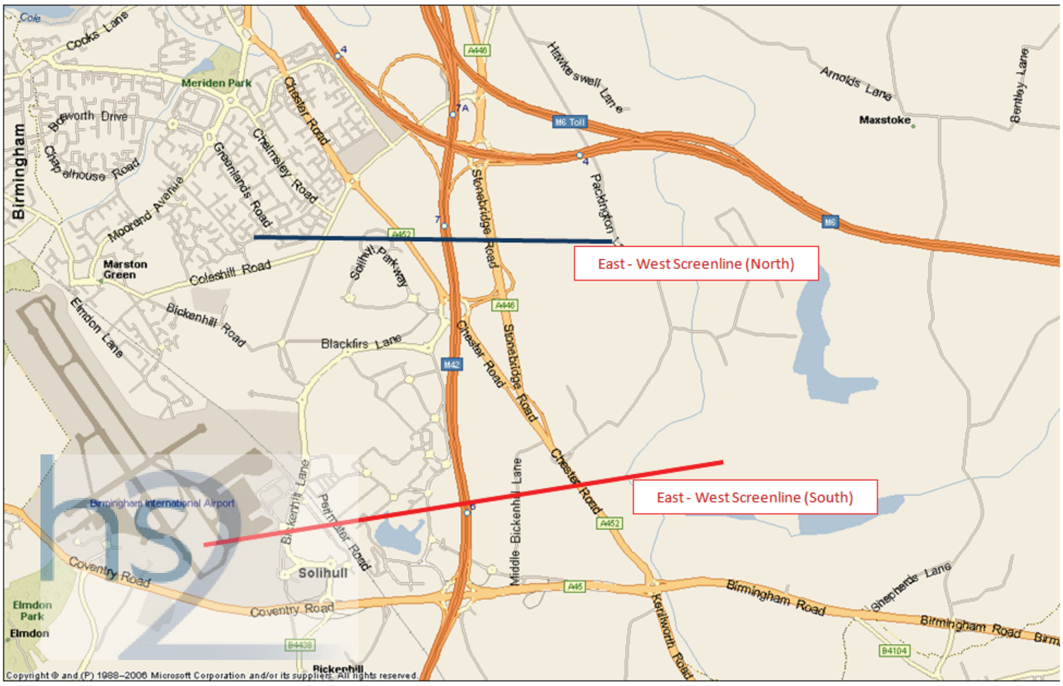


Figure 3.1 VISSIM Model – Location of Screenlines

In accordance with the DMRB validation criteria as discussed in Section 3.3, the screenline validation results for each of the Weekday AM and PM modelled hours are summarised in Tables 3.7 and 3.8, respectively.

Table 3.7 Screenline Validation Results – Weekday AM Summary

Criteria	Target	Weekday AM Modelled Hour (08:00-09:00)
Total screenline flows to be within 5%	All (or nearly all) screenlines	4 out of 4
Screenline totals: GEH<4	All (or nearly all) screenlines	4 out of 4

Table 3.8 Screenline Validation Results – Weekday PM Summary

Criteria	Target	Weekday PM Modelled Hour (17:00-18:00)
Total screenline flows to be within 5%	All (or nearly all) screenlines	4 out of 4
Screenline totals: GEH<4	All (or nearly all) screenlines	4 out of 4

From the above tables, it is concluded that both modelled time periods satisfy the required screenline validation requirements, particularly as all screenline counts meet the GEH statistic validation criteria.

3.7 Journey Time Comparisons

Taking into consideration that all turning counts, link flows and screenline counts for both the Weekday AM and PM peak periods easily met the required validation criteria, there is an option not to include journey time comparisons due to the fact that the network area was sufficiently small so as to not require a full journey time comparison. This is emphasised in the *'Microsimulation Consultancy Good Practice Guide'* which notes that:

> *"…… if the model is relatively small, journey time comparisons may not be required".*

However, for completeness of validation exercise, this report presents the results of the modelled journey times throughout the modelled network and compares these to the observed journey times. The journey times were recorded along four individual routes (bi-directional) as described below. Figure 3.2 illustrates the journey routes.

- **Route 1: A45**

  Eastbound – Goodway Rd Junction to Shepherds Lane Junction

  Westbound – Shepherds Lane Junction to Goodway Rd Junction

- **Route 2: A446**

  Northbound – A45 / A452 Roundabout to A446 / B4117 Junction

  Southbound – A446 / B4117 Junction to A45 / A452 Roundabout

- **Route 3: M42**

  Northbound – Centre of M42 Junction 6 to Centre of M6 / M42 Interchange

  Southbound – Centre of M6 / M42 Interchange to Centre of M42 Junction 6

- **Route 4: A452**

  Northbound – A452 / B4201 Roundabout to A452 / Coleshill Heath Rd Roundabout

Southbound – A452 / Coleshill Heath Rd Roundabout to A452 / B4201 Roundabout

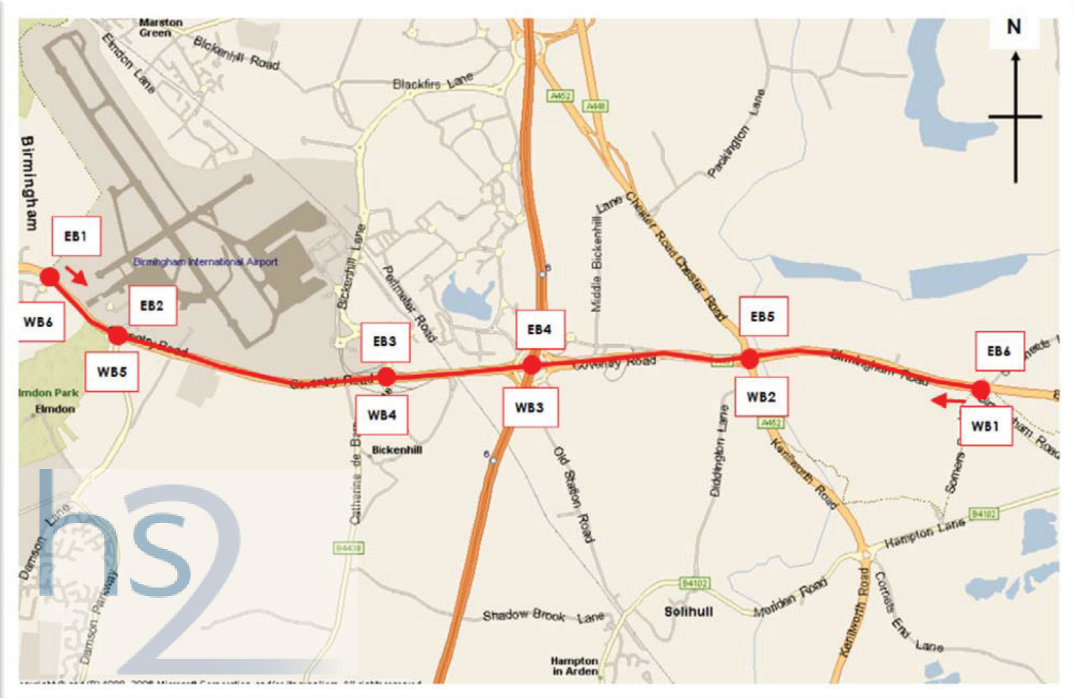


Figure 3.2a VISSIM Model – Journey Time Survey Route 1

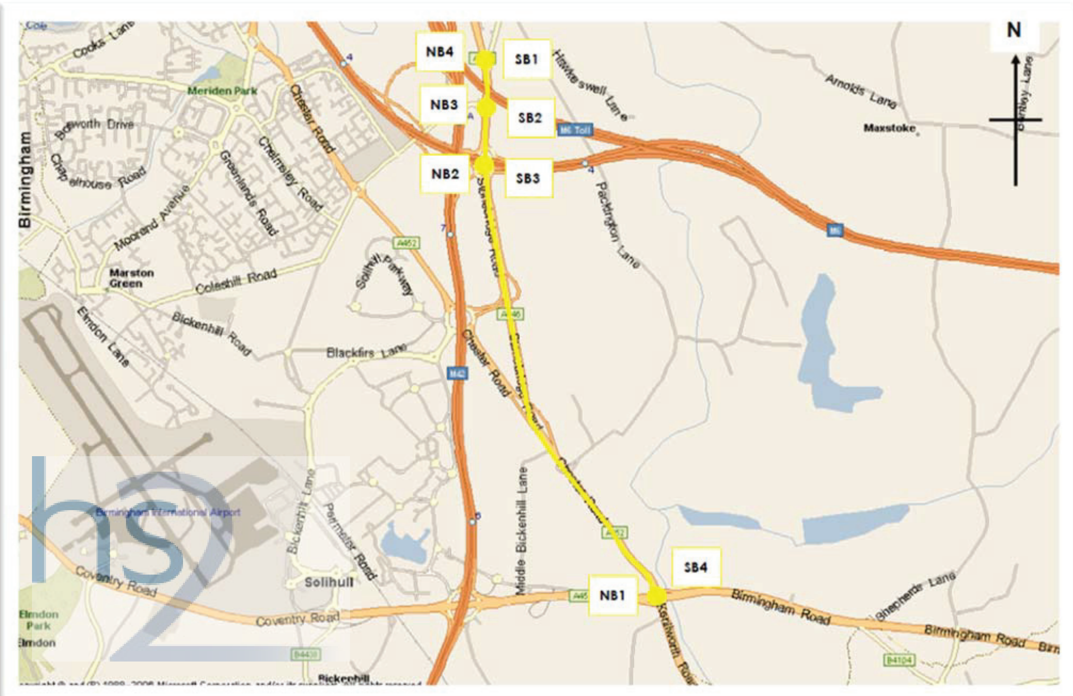


Figure 3.2b VISSIM Model – Journey Time Survey Route 2

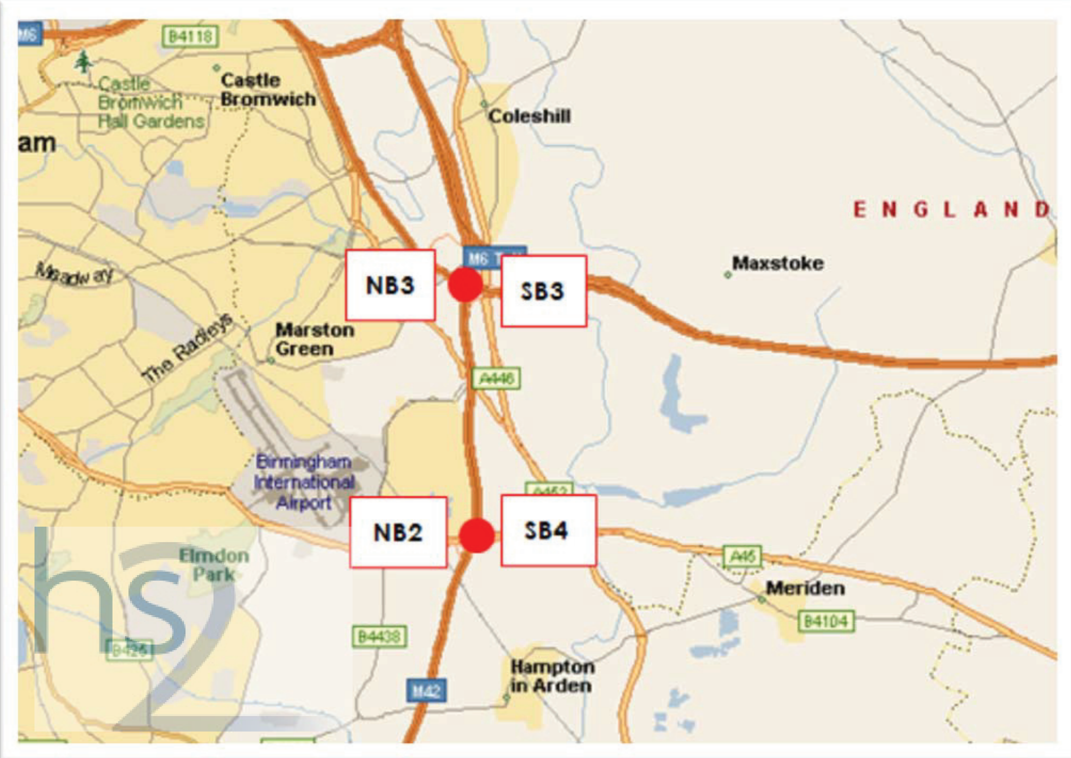


Figure 3.2c VISSIM Model – Journey Time Survey Route 3

Figure 3.2d VISSIM Model – Journey Time Survey Route 4

A minimum of 10 journey time runs were recorded during the survey periods, this information has been used to establish the average observed journey times. Similarly the average modelled journey times was derived from a minimum of 5 model runs, each run using a different random seed value. The variability in observed journey times along with the average observed and average modelled times are summarised in Charts 3.1 to 3.8.

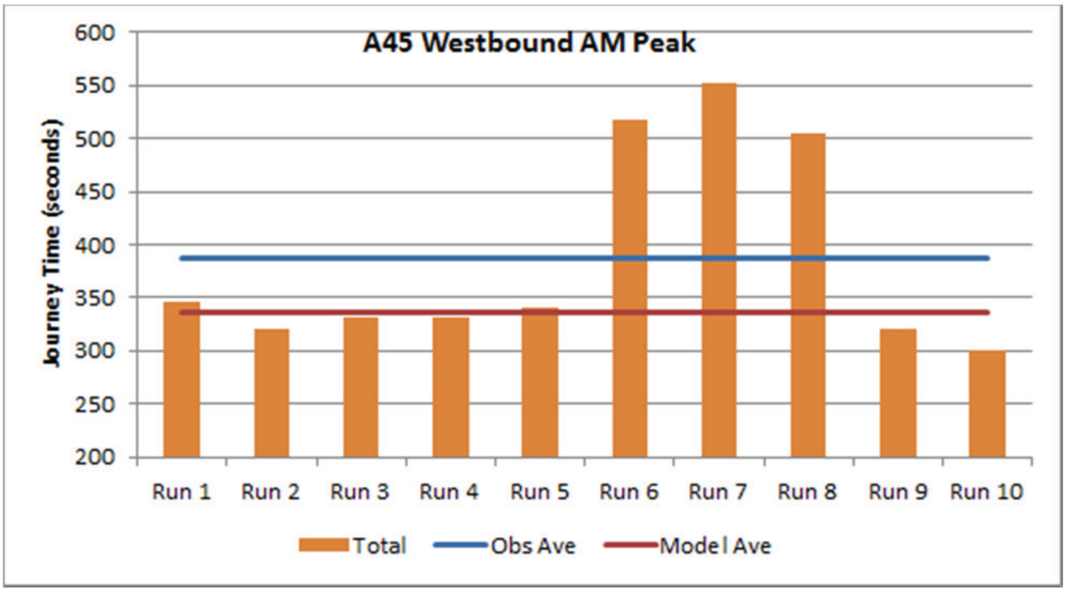


Chart 3.1a A45 Westbound AM Peak Journey Times Analysis

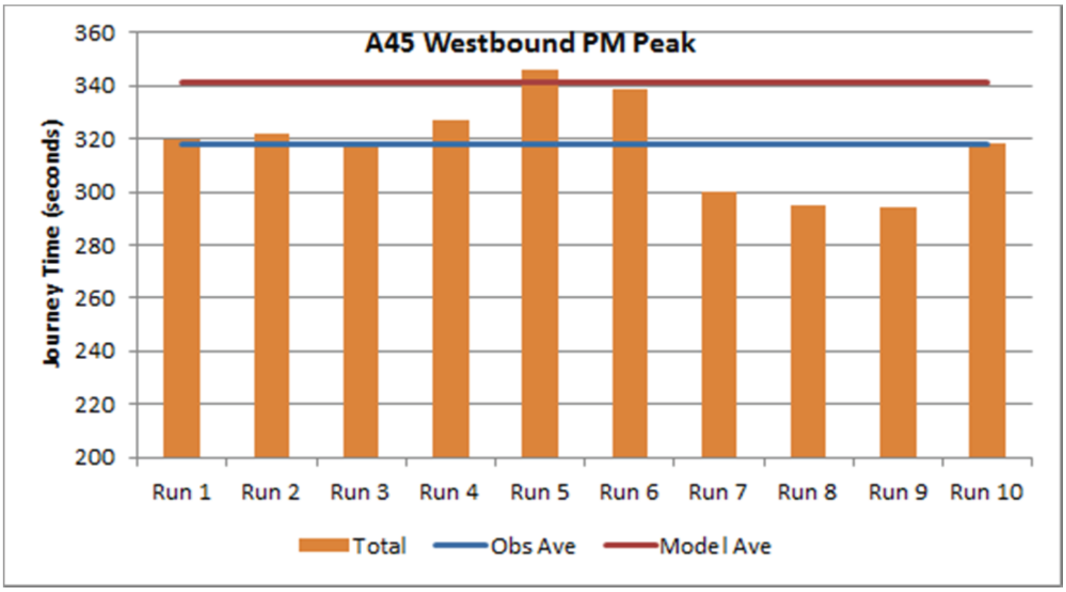


Chart 3.1b A45 Westbound PM Peak Journey Times Analysis

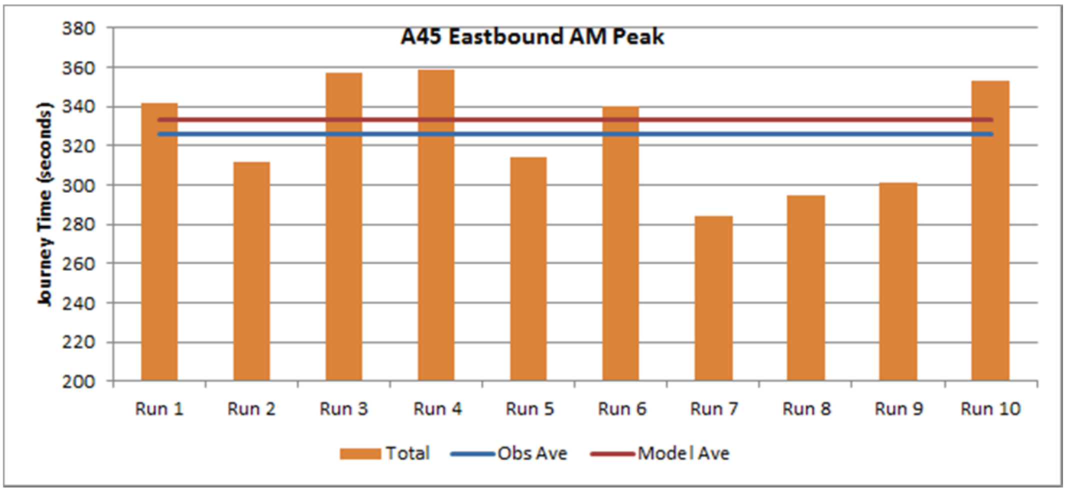


Chart 3.1c A45 Eastbound AM Peak Journey Times Analysis

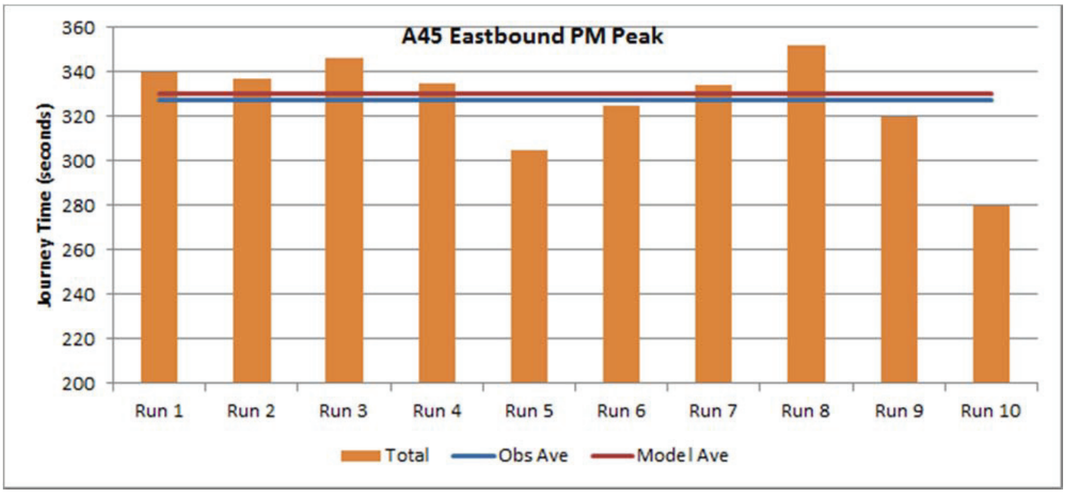


Chart 3.1d A45 Eastbound PM Peak Journey Times Analysis

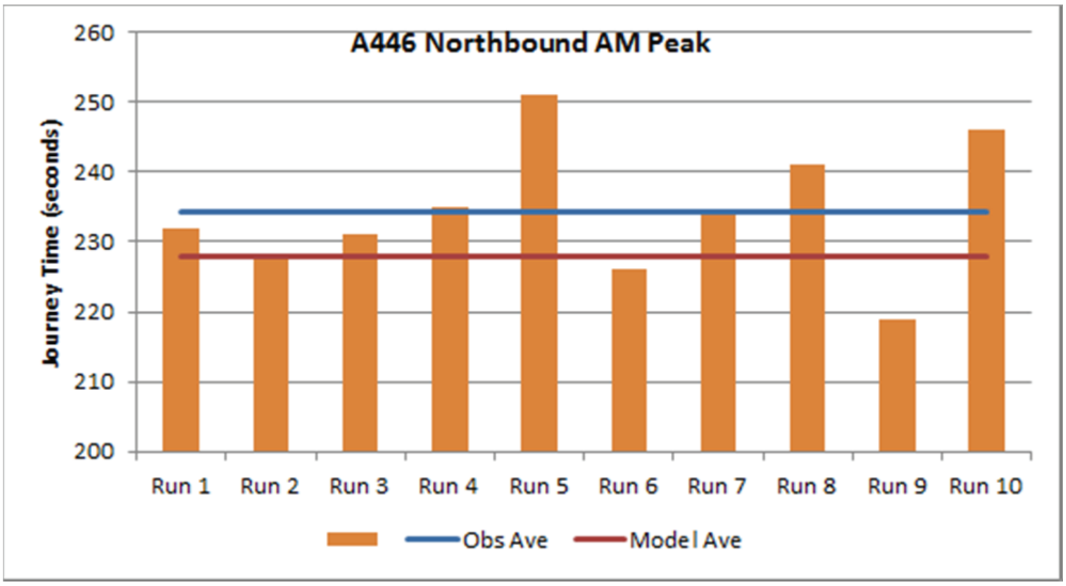


Chart 3.2a A446 Northbound AM Peak Journey Times Analysis

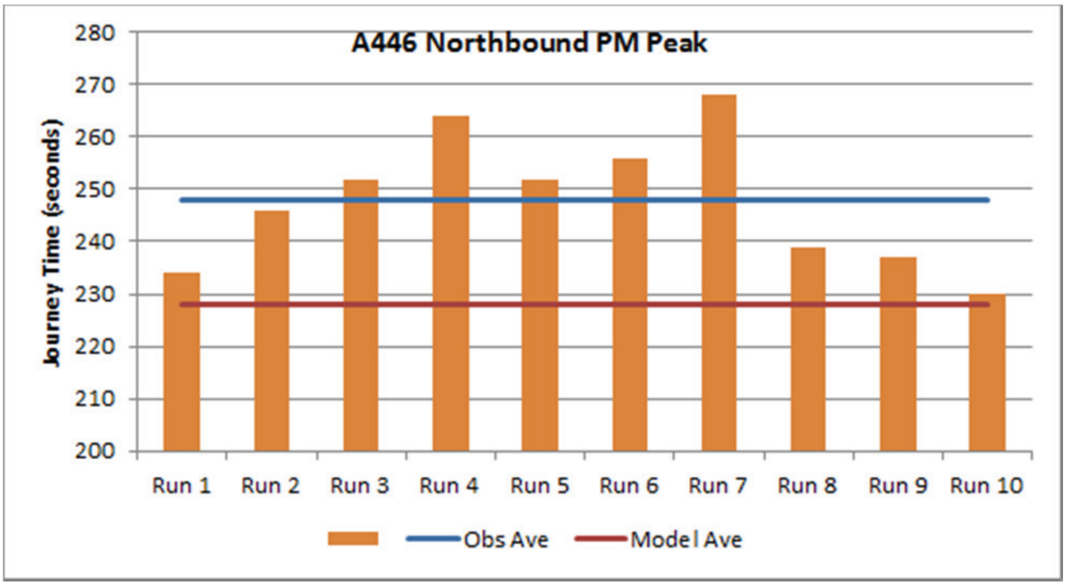


Chart 3.2b A446 Northbound PM Peak Journey Times Analysis

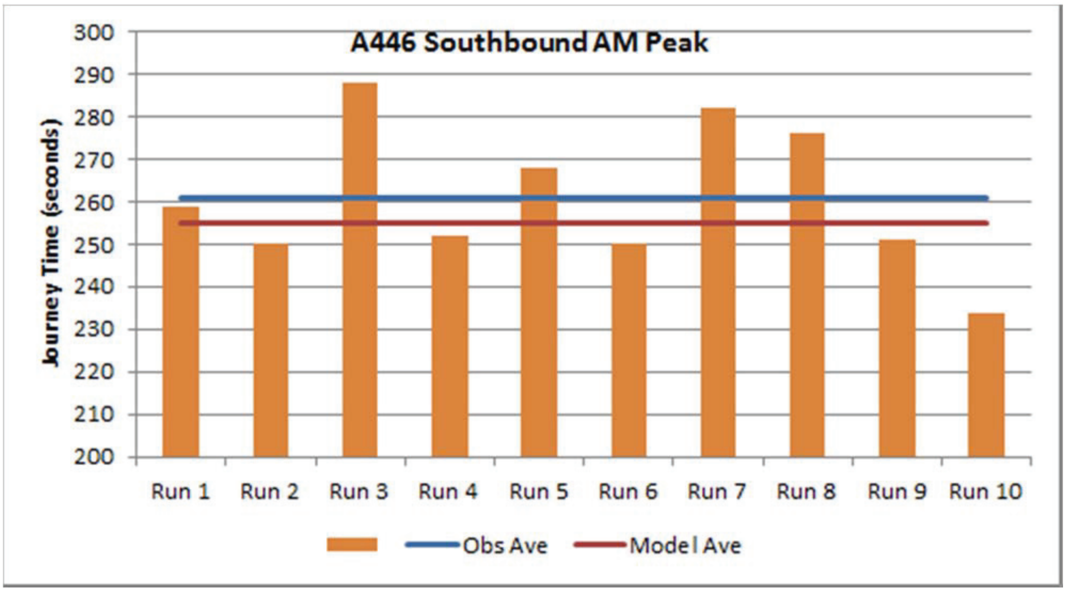


Chart 3.2c A446 Southbound AM Peak Journey Times Analysis

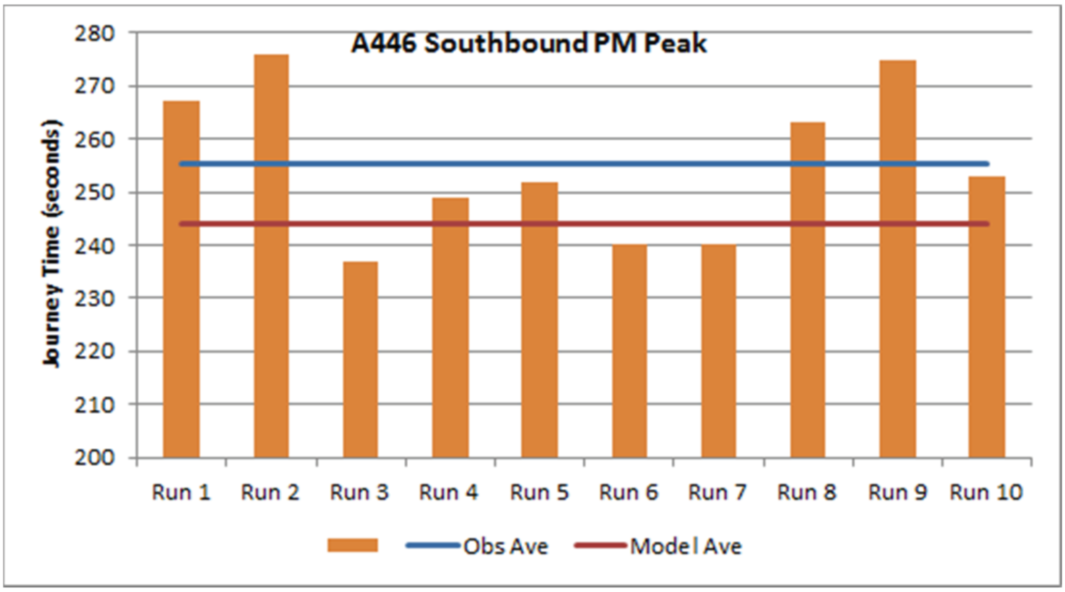


Chart 3.2d A446 Southbound PM Peak Journey Times Analysis

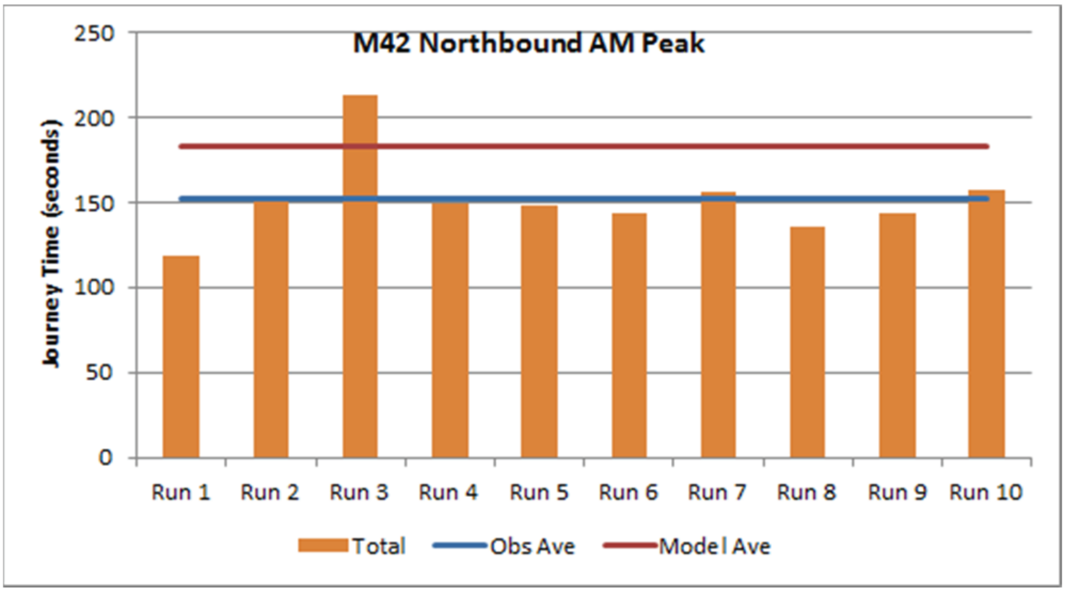


Chart 3.3a M42 Northbound AM Peak Journey Times Analysis

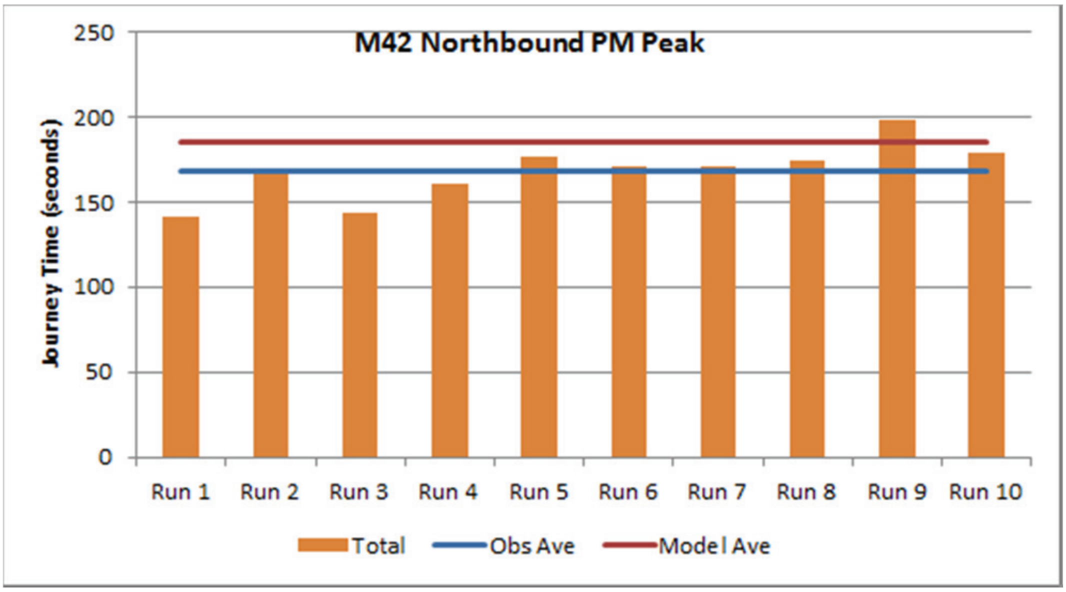


Chart 3.3b M42 Northbound PM Peak Journey Times Analysis

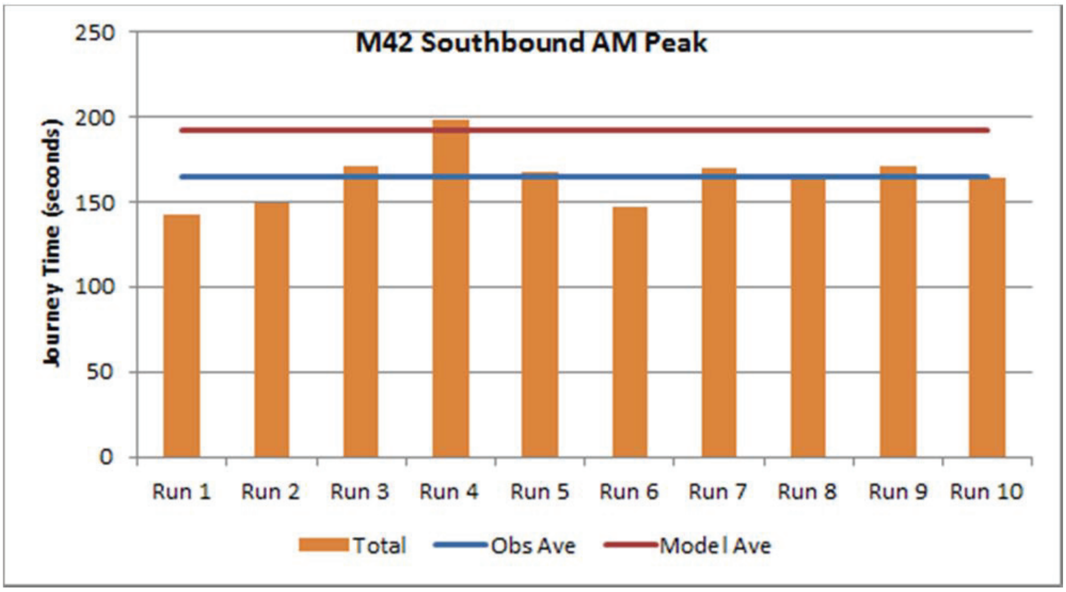


Chart 3.3c M42 Southbound AM Peak Journey Times Analysis

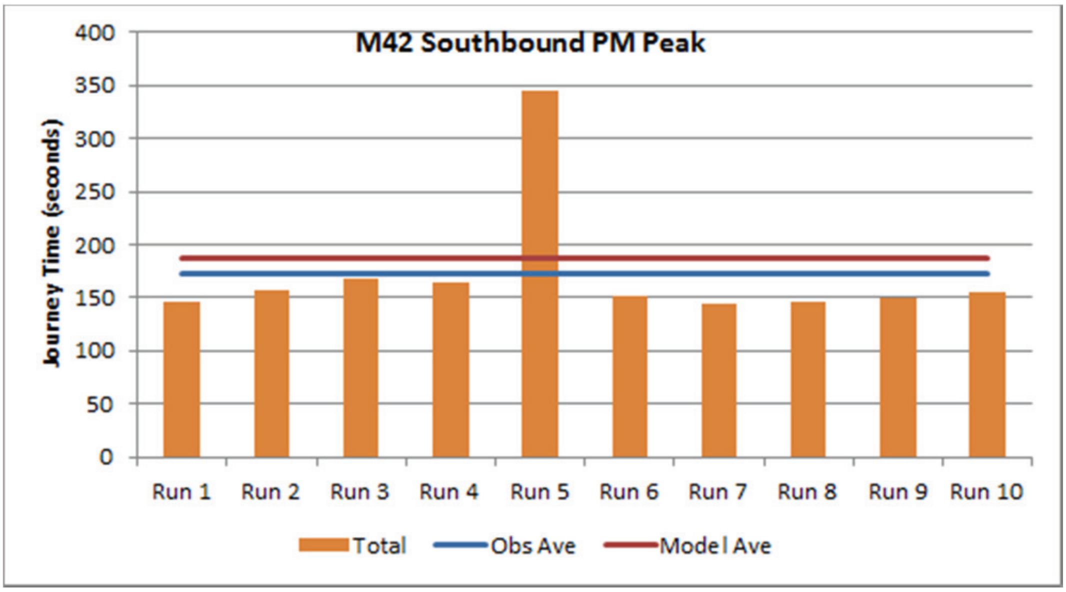


Chart 3.3d M42 Southbound PM Peak Journey Times Analysis

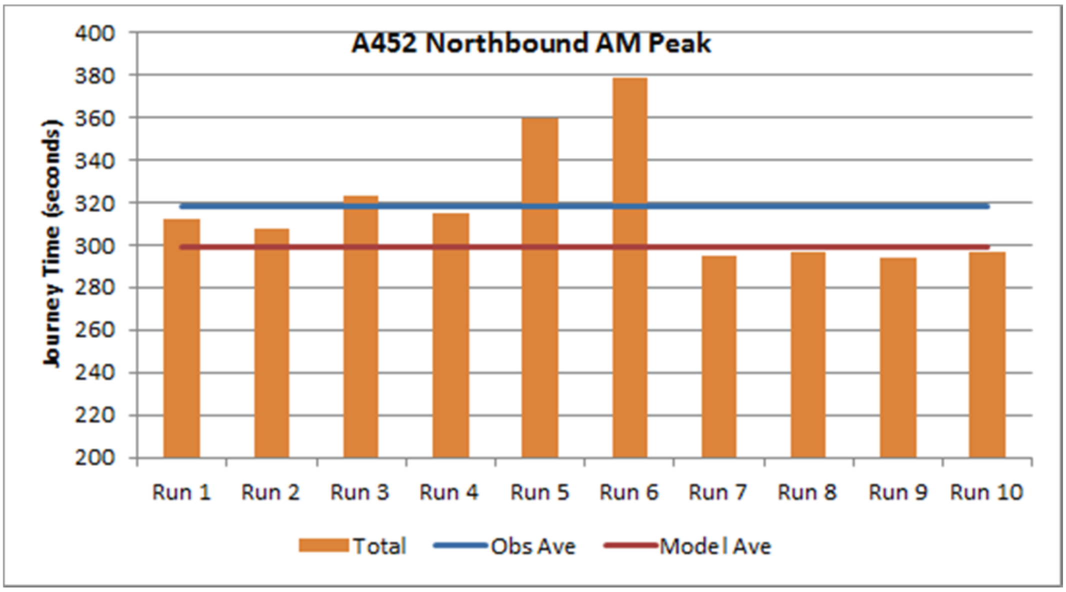


Chart 3.4a A452 Northbound AM Peak Journey Times Analysis

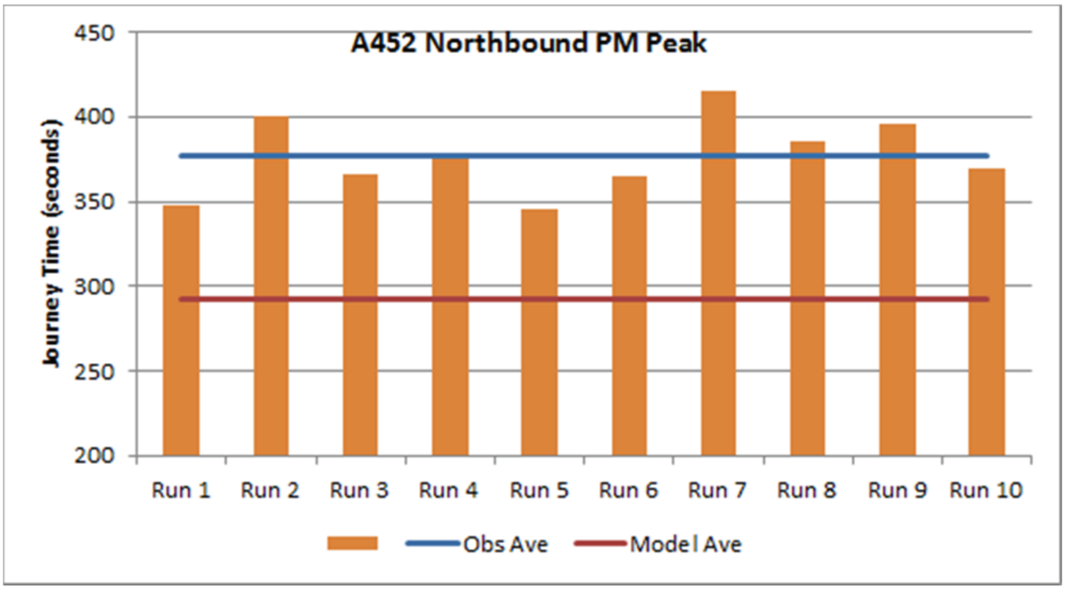


Chart 3.4b A452 Northbound PM Peak Journey Times Analysis

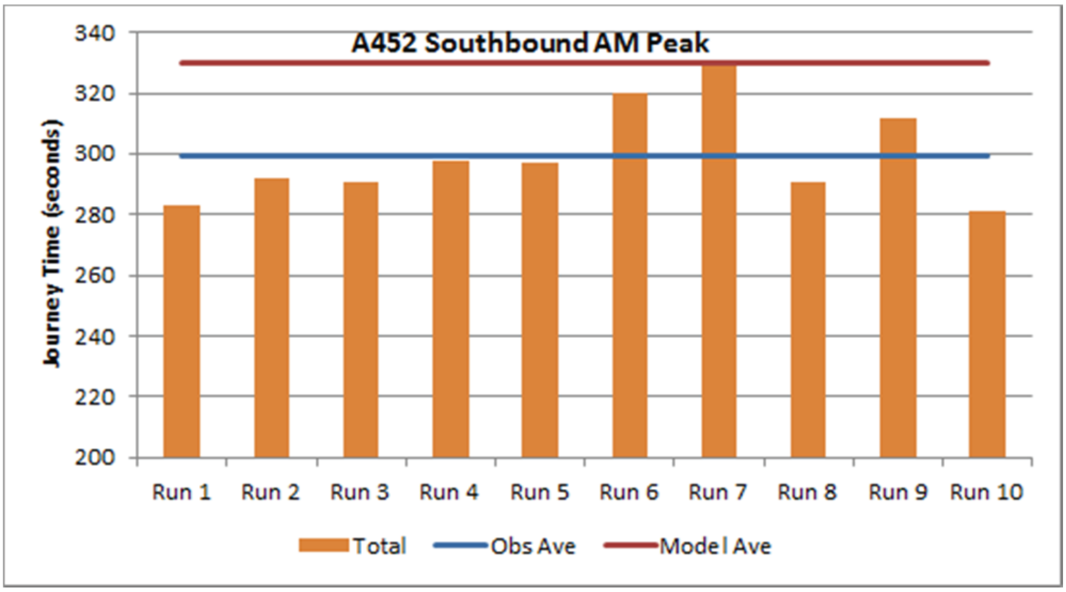


Chart 3.4c A452 Southbound AM Peak Journey Times Analysis

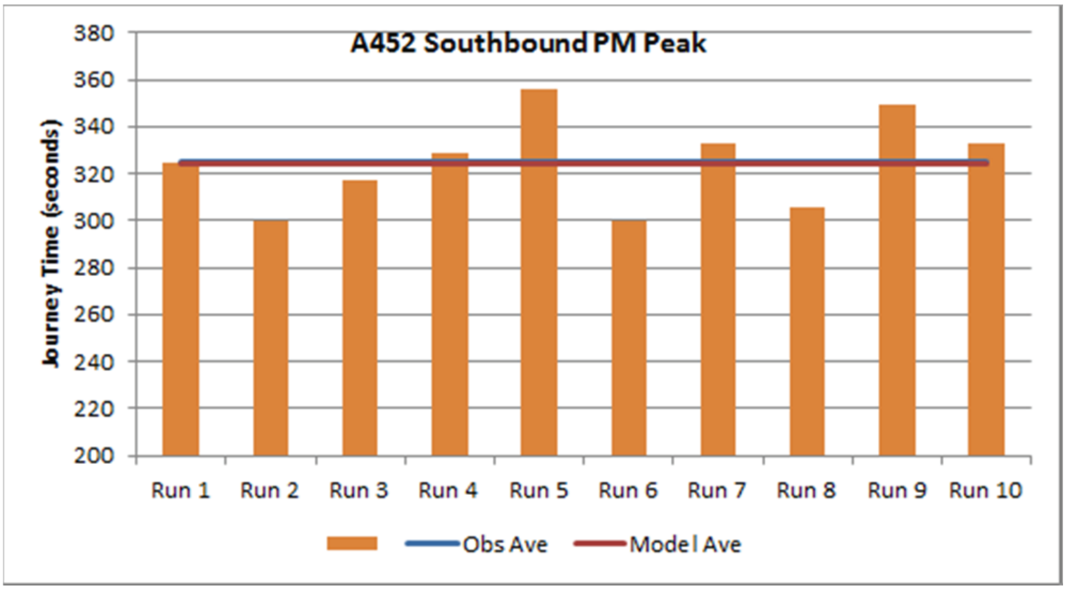


Chart 3.4d A452 Southbound PM Peak Journey Times Analysis

These charts highlights relatively stable conditions during the AM and PM peak periods, with consistent time recorded during the 10 runs and allowing the calculation of robust average.

As shown modelled journey times generally met the required DMRB validation guidelines for the majority of surveyed routes. The results are summarised in Tables 3.9 and 3.10. Similarly, in considering the journey times within the context of the <1 minute criteria, the majority of modelled journey time data meets the required DMRB validation criteria. It is therefore considered that the 2012 Base model is robust and fit for purpose.

Table 3.9 Journey Time Validation Results – Weekday AM Summary

Criteria	Target	Weekday AM Modelled Hour (08:00-09:00)
Total journey time to be within 15%	All (or nearly all) screenlines	7 out of 8
Total journey time to be <1 min	All (or nearly all) screenlines	7 out of 8

Table 3.10 Journey Time Validation Results – Weekday PM Summary

Criteria	Target	Weekday PM Modelled Hour (17:00-18:00)
Total journey time to be within 15%	All (or nearly all) screenlines	7 out of 8
Total journey time to be <1 min	All (or nearly all) screenlines	7 out of 8

3.8 Validation Summary

A thorough model validation process has been carried out to ensure that the M42/A45 Base model represents and reflects observed and field-measured conditions as closely as possible. While there are minor variations from DMRB criteria, the overall results demonstrate that both the Weekday AM and PM scenarios generally meet the key acceptability criteria and validation targets in the majority of cases. A summary of these validation results is provided in Tables 3.11 and 3.12.

Table 3.11 Validation Results – Weekday AM Summary

Data Type	Criteria / Target	Weekday AM Modelled Hour (08:00-09:00)
Turning Counts	GEH<5	89%
	Flows <700vph	91%
	Flows 700vph-2,700vph	100%
Link Flows	GEH<5	88%
	Flows <700vph	87%
	Flows 700vph-2,700vph	88%
Screenlines	Totals to be within 5%	4 out of 4
	GEH<4	4 out of 4
Journey Times	Totals to be within 15%	7 out of 8
	To be <1 min	7 out of 8

Table 3.12 Validation Results – Weekday PM Summary

Data Type	Criteria / Target	Weekday PM Modelled Hour (17:00-18:00)
Turning Counts	GEH<5	87%
	Flows <700vph	96%
	Flows 700vph-2,700vph	75%
Link Flows	GEH<5	88%
	Flows <700vph	94%
	Flows 700vph-2,700vph	87%
Screenlines	Totals to be within 5%	4 out of 4
	GEH<4	4 out of 4
Journey Times	Totals to be within 15%	7 out of 8
	To be <1 min	7 out of 8

The Screenline results are shown to match DMRB criteria in 4 out of 4 cases, with the journey time results generally comply in 7 out of 8 routes.

As the majority of the results are compliant with DRMB, with those non-compliant results being marginally outside the DMRB criteria, we are confident that the PM peak model remains valid and fit for purpose.

3.9 M42 and M6 Slip Road – Queue Lengths

While not forming part of the validation exercise, for reference purposes the observed and modelled queue lengths on the M42 Junction 6 and M6 Junction 4 off-slips are presented in Table 3.13. These demonstrate that queue lengths (both observed and modelled) are managed within the slip-roads with no excessive queuing identified.

Table 3.13 M42 and M6 off-slip Queue Length (m)

Approach	AM Peak		PM Peak	
	Observed (MMQ / Max)	**Modelled (Ave / Max)**	**Observed** (MMQ / Max)	**Modelled (Ave / Max)**
M42 N, off-slip	35 / 85	12 / 70	22 / 45	9 / 74
M42 S, off-slip	53 / 90	13 / 78	42 / 85	8 / 56
	Observed (MMQ / Max)	**Modelled (Ave)**	**Observed** (MMQ / Max)	**Modelled (Ave)**
M6 W, off-slip	30 / 95	23	35 / 95	107
M6 E, off-slip	15 / 30	8	8 / 25	3

In reviewing Table 3.13, it is clear that the VISSIM model broadly provides a reasonable representation of queues on M42 Junction 6 and M6 Junction 4. In considering queue comparisons, it is worth noting that the definition and interpretation of a queuing vehicle has the potential for variation between observed and modelled results. Within VISSIM there are specific settings based on vehicle speed and headway to define a queue, whereas on-site observations require a visual interpretation of the extent of the queue and therefore there will be an inherent difference.

It should also be noted that the variability in actual queues on M42 Junction 6 is heavily influenced by the changes in traffic patterns from day to day as a result of the influence of factors including the NEC and the airport, road conditions and driver behaviour.

In overall terms, the VISSIM model is considered to provide a reasonable representation of queues for assessment purposes.

4 Summary and Conclusions

4.1 Summary

The purpose of this report is to summarise the model development, calibration and validation exercise for the Birmingham Airport local area network VISSIM model. The report outlines the methodology and output results, and aims to demonstrate that the AM and PM models are suitable for use in the assessment of future year scenarios in relation to the HS2 Birmingham airport interchange.

The study area for the VISSIM model focuses on the strategic and local road network in the vicinity of Birmingham airport and the NEC exhibition centre. The majority of the study area is included within the original 2009 Base VISSIM model, however the network was extended north to include M6 Junction 4 and M42 Junction 7a slip road, and additional local road links around the exhibition centre, airport and train station.

In utilising the 2009 VISSIM model, the majority of the core modelling parameters and indeed local characteristics, have been incorporated within the base network. This model has been used in support of numerous planning applications and proposals for the local area, where both the local authority and the Highway Agency (HA) have accepted the model.

In accordance with DMRB, a selection of independent data was 'held back' from the matrix development process to be used for validation purposes. However, due to the difficulty in obtaining two completely independent sets of survey data for the same time periods / years and at the same locations, a small number of traffic counts used in the calibration process have also be used for validation checks. This is accepted practice and it has therefore been deemed to be acceptable for the purposes of developing a suitable Base model fit for the purpose of assessing the future Birmingham interchange proposals.

For the purposes of validation, the operation of the VISSIM network was checked using four main data types, namely:

- Turning counts;
- Link counts;
- Screenline counts; and
- Journey time data.

All traffic flow data was compared over the relevant Weekday AM and PM peak hours and, in accordance with DMRB, was directional.

4.2 Conclusions

Based on a review of the validation results in the context of DMRB criteria, and taking into consideration the extent of the modelled network and known variability in the network operation, the model is shown to be fit for purpose.

The validation summary tables identified the Weekday AM peak results to fully comply with DMRB assessment criteria, with only 1 out of the 8 journey time results being non-compliant.

Similarly, the PM Peak model results are compliant with the majority of DMRB criteria. Turning counts validation for flows between 700 and 2,700 complied in 75% of results however this is based on 9 counts out of 12 which is a relatively small sample size. Journey time results are in compliant in 7 out of 8 routes, which is considered acceptable.

As the majority of the PM Peak validation results are compliant with DMRB, and any non-compliant results being marginally outside the DMRB criteria, we are confident that both the AM and PM peak model remains valid and fit for purpose.

A1

Junction Turning Count Validation

AM Peak – Junction Turning Count Validation

Intersection	Name	Observed	Modelled	Difference	GEH
A45 / Damson Parkway	Terminal Road - Left Turn	106	106	0	0.0
	Terminal Road - Ahead	4	5	1	0.5
	Terminal Road - Right Turn	48	47	-1	0.1
	A45 East - Left Turn	315	289	-26	1.5
	A45 East - Ahead	1420	1450	30	0.8
	A45 East Right Turn	144	124	-20	1.7
	Damson Parkway - Left Turn	158	142	-16	1.3
	Damson Parkway - Ahead	18	31	13	2.6
	Damson Parkway - Right Turn	423	446	23	1.1
	A45 West - Left Turn	315	340	25	1.4
	A45 West - Ahead	1398	1351	-47	1.3
	A45 West - Right Turn	144	163	19	1.5
A45 / B4438	B4438 North - Left Turn to A45 East	227	246	19	1.3
	B4438 North - Ahead to B4438 South	276	255	-21	1.3
	B4438 North - Right Turn to A45 West	261	263	2	0.1
	A45 East - Left Turn to B4438 South	86	128	42	4.1
	A45 East - Ahead to A45 West				
	A45 East - Right Turn to B4438 North	606	598	-8	0.3
	B4438 South - Left Turn to A45 West	51	43	-8	1.2
	B4438 South - Ahead to B4438 North	370	326	-44	2.3
	B4438 South - Right Turn to A45 East	177	230	53	3.7
	A45 West - Left Turn to B4438 North	104	121	17	1.6
	A45 West - Ahead to A45 East				
	A45 West - Right Turn to B4438 South	37	54	17	2.5
M42 Junction 6	M42 North - Left Turn to A45 East	577	555	-22	0.9
	M42 North - Ahead to M42 South	3923	3945	22	0.3
	M42 North - Right Turn to A45 West	972	958	-14	0.4
	M42 North - Right Turn to S Way	7	6	-1	0.6
	A45 East - Left Turn to M42 South	877	759	-118	4.1
	A45 East - Ahead to A45 West	5	0	-5	3.2
	A45 East - Right Turn to S Way	4	13	9	3.0
	A45 East - Right Turn to M42 North	403	281	-122	6.6
	M42 South - Left Turn to A45 West	851	746	-105	3.7
	M42 South Left Turn to S Way	314	346	32	1.8
	M42 South - Ahead to M42 North	2991	3084	93	1.7
	M42 South - Right Turn to A45 East	870	781	-89	3.1
	A45 West - Left Turn to S Way	92	78	-14	1.6
	A45 West - Left Turn to M42 North	599	582	-17	0.7
	A45 West - Ahead to A45 East	943	1045	102	3.2
	A45 West - Right Turn to M42 South	444	394	-50	2.4
	S Way - Left Turn to M42 North	27	144	117	12.6
	S Way - Ahead to A45 East	47	12	-35	6.5
	S Way - Right Turn to M42 South	55	79	24	2.9
	S Way - Right Turn to A45 West	5	3	-2	1.1
A45 / A452	A452 North - Left Turn to A45 East	540	550	10	0.4
	A452 North - Ahead to A452 South	706	713	7	0.2
	A452 North - Right Turn to A45 West	612	612	0	0.0
	A45 East - Left Turn to A452 South	20	14	-6	1.5
	A45 East - Ahead to A45 West				
	A45 East - Right Turn to A452 North	493	408	-85	4.0
	A452 South - Left Turn to A45 West	389	406	17	0.9
	A452 South - Ahead to A452 North	619	641	22	0.9
	A452 South - Right Turn to A45 East	14	8	-6	1.8
	A45 West - Left Turn to A452 North	666	856	190	6.9
	A45 West - Ahead to A45 East				
	A45 West - Right Turn to A452 South	539	527	-12	0.5
A452 / B4102	A452 North - Left Turn to B4102 East	281	335	54	3.1
	A452 North - Ahead to Comets End Lane	186	190	4	0.3
	A452 North - Right Turn to A452 South	598	629	31	1.2
	A452 North - Right Turn to B4102 West	104	59	-45	5.0
	B4102 East - Left Turn to Comets End Lane	10	4	-6	2.3
	B4102 East - Left Turn to A452 South	114	111	-3	0.2
	B4102 East - Ahead to B4102 West	136	139	3	0.2
	B4102 East - Right Turn to A452 North	55	63	8	1.1
	Comets End Lane - Left Turn to A452 South	3	3	0	0.0
	Comets End Lane - Left Turn to B4102 West	16	16	0	0.0
	Comets End Lane - Ahead to A452 North	68	66	-2	0.3
	Comets End Lane - Right Turn to B4102 East	9	8	-1	0.4
	A452 South - Left Turn to B4102 West	66	67	1	0.1
	A452 South - Ahead to A452 North	858	856	-2	0.1
	A452 South - Right Turn to B4102 East	76	77	1	0.1
	A452 South - Right Turn to Comets End Lane	0	0	0	0.0
	B4102 West - Left Turn to A452 North	20	60	40	6.3
	B4102 West - Ahead to B4102 East	196	196	0	0.0
	B4102 West - Right Turn to Comets End Lane	17	17	0	0.0
	B4102 West - Right Turn to A452 South	51	51	0	0.0
A452 / A446	A446 - Left Turn to A452 South	8	0	-8	4.0
	A446 - Ahead to B4438	117	218	101	7.8
	A446 - Ahead to Solihull Parkway	522	442	-80	3.7
	A446 - Right Turn to A452 North	15	16	1	0.3
	A452 South - Left Turn to B4438	8	17	9	2.6
	A452 South - Left Turn to Solihull Parkway	508	450	-58	2.7
	A452 South - Ahead to A452 North	258	385	127	7.1
	A452 South - Right Turn to A446	6	0	-6	3.5
	B4438 - Left Turn to Solihull Parkway	330	77	-253	17.7
	B4438 - Left Turn to A452 North	152	178	26	2.0
	B4438 - Ahead to A446	79	118	39	3.9
	B4438 - Right Turn to A452 South	17	39	22	4.1
	Solihull Parkway - Left Turn to A452 North	27	44	17	2.9
	Solihull Parkway - Ahead to A446	22	14	-8	1.9
	Solihull Parkway - Right Turn to A452 South	25	26	1	0.2
	Solihull Parkway - Right Turn to B4438	36	23	-13	2.4
	A452 North - Left Turn to A446	10	24	14	3.3
	A452 North - Ahead to A452 South	647	611	-36	1.4
	A452 North - Right Turn to B4438	357	259	-98	5.6
	A452 North - Right Turn to Solihull Parkway	173	213	40	2.9
M6 Junction 4	A446 North - Left Turn to M6 East	218	199	-19	1.3
	A446 North - Ahead to A446 South	691	737	46	1.7
	A446 North - Right Turn to M6 West	231	212	-19	1.3
	M6 East - Left Turn to A446 South	312	389	77	4.1
	M6 East - Ahead to M6 West				
	M6 East - Right Turn to A446 North	191	186	-5	0.4
	A446 South - Left Turn to M6 West	132	341	209	13.6
	A446 South - Ahead to A446 North	712	677	-35	1.3
	A446 South - Right Turn to M6 West	165	191	26	1.9
	M6 West - Left Turn to A446 North	272	353	81	4.6
	M6 West - Ahead to M6 East				
	M6 West - Right Turn to A446 South	763	758	-5	0.2
Stonebridge Rd / Coleshill Heath Rd	Stonebridge Rd North - Left Turn to Stonebridge Rd South	981	1073	92	2.9
	Stonebridge Rd North - Right Turn to Coleshill Heath Rd	392	284	-108	5.9
	Stonebridge Rd South - Left Turn to Coleshill Heath Rd	250	305	55	3.3
	Stonebridge Rd South - Right Turn to Stonebridge Rd North	913	912	-1	0.0
	Coleshill Heath Rd - Left Turn to Stonebridge Rd North	233	247	14	0.9
	Coleshill Heath Rd - Right Turn to Stonebridge Rd South	153	68	-85	8.0

PM Peak – Junction Turning Count Validation

Intersection	Name	Observed	Modelled	Difference	GEH
A45 / Damson Parkway	Terminal Road - Left Turn	140	141	1	0.1
	Terminal Road - Ahead	29	29	0	0.0
	Terminal Road - Right Turn	60	61	1	0.1
	A45 East - Left Turn	434	447	13	0.6
	A45 East - Ahead	1892	1877	-15	0.4
	A45 East Right Turn	97	97	0	0.0
	Damson Parkway - Left Turn	213	222	9	0.6
	Damson Parkway - Ahead	9	0	-9	4.2
	Damson Parkway - Right Turn	410	404	-6	0.3
	A45 West - Left Turn	434	442	8	0.4
	A45 West - Ahead	1422	1410	-12	0.3
	A45 West - Right Turn	97	115	18	1.7
A45 / B4438	B4438 North - Left Turn to A45 East	681	521	-160	6.5
	B4438 North - Ahead to B4438 South	414	455	41	2.0
	B4438 North - Right Turn to A45 West	570	482	-88	3.8
	A45 East - Left Turn to B4438 South	145	232	87	6.3
	A45 East - Ahead to A45 West				
	A45 East - Right Turn to B4438 North	242	178	-64	4.4
	B4438 South - Left Turn to A45 West	54	60	6	0.8
	B4438 South - Ahead to B4438 North	322	258	-64	3.8
	B4438 South - Right Turn to A45 East	67	118	51	5.3
	A45 West - Left Turn to B4438 North	36	47	11	1.7
	A45 West - Ahead to A45 East				
	A45 West - Right Turn to B4438 South	85	57	-28	3.4
M42 Junction 6	M42 North - Left Turn to A45 East	328	399	71	3.7
	M42 North - Ahead to M42 South	3754	3698	-56	0.9
	M42 North - Right Turn to A45 West	857	953	96	3.2
	M42 North - Right Turn to S Way	3	15	12	4.0
	A45 East - Left Turn to M42 South	1121	1016	-105	3.2
	A45 East - Ahead to A45 West	0	0	0	0.0
	A45 East - Right Turn to S Way	17	3	-14	4.6
	A45 East - Right Turn to M42 North	489	510	21	0.9
	M42 South - Left Turn to A45 West	539	587	48	2.0
	M42 South Left Turn to S Way	173	174	1	0.1
	M42 South - Ahead to M42 North	3980	3978	-2	0.0
	M42 South - Right Turn to A45 East	658	612	-46	1.8
	A45 West - Left Turn to S Way	66	50	-16	2.1
	A45 West - Left Turn to M42 North	989	1004	15	0.5
	A45 West - Ahead to A45 East	1351	1495	144	3.8
	A45 West - Right Turn to M42 South	596	671	75	3.0
	S Way - Left Turn to M42 North	67	153	86	8.2
	S Way - Ahead to A45 East	63	37	-26	3.6
	S Way - Right Turn to M42 South	116	182	66	5.4
	S Way - Right Turn to A45 West	7	39	32	6.7
A45 / A452	A452 North - Left Turn to A45 East	644	701	57	2.2
	A452 North - Ahead to A452 South	719	597	-122	4.8
	A452 North - Right Turn to A45 West	831	679	-152	5.5
	A45 East - Left Turn to A452 South	18	13	-5	1.3
	A45 East - Ahead to A45 West				
	A45 East - Right Turn to A452 North	444	415	-29	1.4
	A452 South - Left Turn to A45 West	388	423	35	1.7
	A452 South - Ahead to A452 North	648	717	69	2.6
	A452 South - Right Turn to A45 East	42	37	-5	0.8
	A45 West - Left Turn to A452 North	461	614	153	6.6
	A45 West - Ahead to A45 East				
	A45 West - Right Turn to A452 South	463	503	40	1.8
A452 / B4102	A452 North - Left Turn to B4102 East	160	155	-5	0.4
	A452 North - Ahead to Comets End Lane	95	91	-4	0.5
	A452 North - Right Turn to A452 South	908	766	-142	4.9
	A452 North - Right Turn to B4102 West	116	52	-64	6.9
	B4102 East - Left Turn to Comets End Lane	0	0	0	0.0
	B4102 East - Left Turn to A452 South	141	141	0	0.0
	B4102 East - Ahead to B4102 West	150	150	0	0.0
	B4102 East - Right Turn to A452 North	111	130	19	1.7
	Comets End Lane - Left Turn to A452 South	2	3	1	0.6
	Comets End Lane - Left Turn to B4102 West	21	21	0	0.0
	Comets End Lane - Ahead to A452 North	102	114	12	1.2
	Comets End Lane - Right Turn to B4102 East	11	10	-1	0.2
	A452 South - Left Turn to B4102 West	69	70	1	0.1
	A452 South - Ahead to A452 North	642	754	112	4.2
	A452 South - Right Turn to B4102 East	80	80	0	0.0
	A452 South - Right Turn to Comets End Lane	0	0	0	0.0
	B4102 West - Left Turn to A452 North	43	115	72	8.1
	B4102 West - Ahead to B4102 East	221	218	-3	0.2
	B4102 West - Right Turn to Comets End Lane	19	20	1	0.2
	B4102 West - Right Turn to A452 South	67	67	0	0.0
A452 / A446	A446 - Left Turn to A452 South	27	0	-27	7.3
	A446 - Ahead to B4438	85	87	2	0.2
	A446 - Ahead to Solihull Parkway	19	30	11	2.3
	A446 - Right Turn to A452 North	18	6	-12	3.3
	A452 South - Left Turn to B4438	9	4	-5	2.1
	A452 South - Left Turn to Solihull Parkway	38	28	-10	1.7
	A452 South - Ahead to A452 North	443	446	3	0.1
	A452 South - Right Turn to A446	3	7	4	1.9
	B4438 - Left Turn to Solihull Parkway	23	14	-9	2.1
	B4438 - Left Turn to A452 North	316	367	51	2.7
	B4438 - Ahead to A446	194	198	4	0.3
	B4438 - Right Turn to A452 South	33	51	18	2.7
	Solihull Parkway - Left Turn to A452 North	308	372	64	3.5
	Solihull Parkway - Ahead to A446	354	320	-34	1.8
	Solihull Parkway - Right Turn to A452 South	464	472	8	0.4
	Solihull Parkway - Right Turn to B4438	184	153	-31	2.4
	A452 North - Left Turn to A446	20	0	-20	6.3
	A452 North - Ahead to A452 South	423	536	113	5.2
	A452 North - Right Turn to B4438	155	125	-30	2.5
	A452 North - Right Turn to Solihull Parkway	14	22	8	2.0
M6 Junction 4	A446 North - Left Turn to M6 East	238	258	20	1.2
	A446 North - Ahead to A446 South	389	418	29	1.5
	A446 North - Right Turn to M6 West	408	377	-31	1.6
	M6 East - Left Turn to A446 South	109	143	34	3.1
	M6 East - Ahead to M6 West				
	M6 East - Right Turn to A446 North	113	114	1	0.1
	A446 South - Left Turn to M6 West	110	189	79	6.5
	A446 South - Ahead to A446 North	1066	1101	35	1.1
	A446 South - Right Turn to M6 West	455	475	20	0.9
	M6 West - Left Turn to A446 North	430	459	29	1.4
	M6 West - Ahead to M6 East				
	M6 West - Right Turn to A446 South	577	498	-79	3.4
Stonebridge Rd / Coleshill Heath Rd	Stonebridge Rd North - Left Turn to Stonebridge Rd South	848	925	77	2.6
	Stonebridge Rd North - Right Turn to Coleshill Heath Rd	293	251	-42	2.5
	Stonebridge Rd South - Left Turn to Coleshill Heath Rd	311	400	89	4.7
	Stonebridge Rd South - Right Turn to Stonebridge Rd North	1217	1270	53	1.5
	Coleshill Heath Rd - Left Turn to Stonebridge Rd North	349	361	12	0.6
	Coleshill Heath Rd - Right Turn to Stonebridge Rd South	159	123	-36	3.0

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Birmingham City Centre SATURN Model Logic Check Technical Note

Technical note

Project:	HS2 Birmingham City Centre Modelling	**To:**	[redacted]
Subject:	BCC SATURN Model Logic Check	**From:**	[redacted]
Date:	5th September 2013	**cc:**	[redacted]

1. Introduction

This technical note sets out the findings of the logic check which has been undertaken on the Birmingham City Centre SATURN Model for the HS2 assessment. This check has focussed on the comparison of modelled and observed traffic flows and journey times using data from surveys undertaken in 2012 and 2013 in the Curzon Street area, where the proposed station will be located.

This note considers the following:

- Model background;
- Data collection;
- Base matrix development;
- Base network development; and
- Modelled traffic flows and journey times logic check.

1.1 Birmingham City Centre Model Background

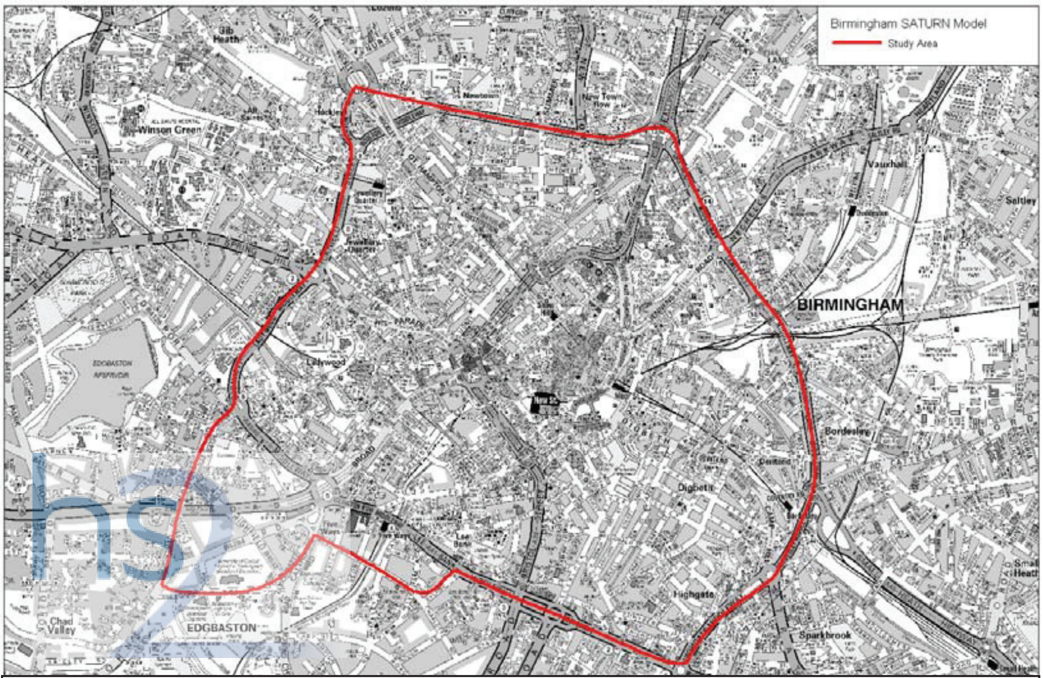
The Birmingham City Centre SATURN model was updated in 2008 to a 2004 base year, as detailed in the report "Birmingham City Centre SATURN Local Model Calibration and Validation report (June 2009), produced by Atkins. The purpose of this update was to enable the more accurate modelling of traffic movements and delays within the congested city centre, compared to the PRISM VISUM model. This enhancement increased confidence in the reliability of the model forecasts by better representation of base year traffic patterns. The model was updated using junction traffic signal timings, junction layout information and bus routes and timetable information. Traffic count surveys, queue/delay surveys and journey time surveys were used to calibrate and validate the model.

Cordon matrices from the PRISM model, processed by the car parking model, form the basis for the SATURN assignments and these have been developed for the following time periods:

- AM Peak: 0800 to 0900;
- PM Peak: 1700 to 1800; and
- Inter-Peak 1000 to 1600 (one hour average period)

The study area for the BCC SATURN model is predominantly within a cordon outside the Ring Road (A4540). The model does, however, extend to the west to include Hagley Road as far as Chad Road. Figure 1.1 shows the extents of the model in red.

Figure 1.1- SATURN Model Area Extent



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The modelled area includes all routes where potential re-routing may occur due to the HS2 scheme and is, therefore, considered to be appropriate for this study.

For the purpose of the HS2 assessment, the base model network and matrices have been updated to a 2012 base year as detailed in the following sections.

2. HS2 Birmingham City Centre SATURN Model Development

The Birmingham City Centre SATURN base year model will form the basis for the future year forecasts for the HS2 assessment of the city centre. This section sets out the following:

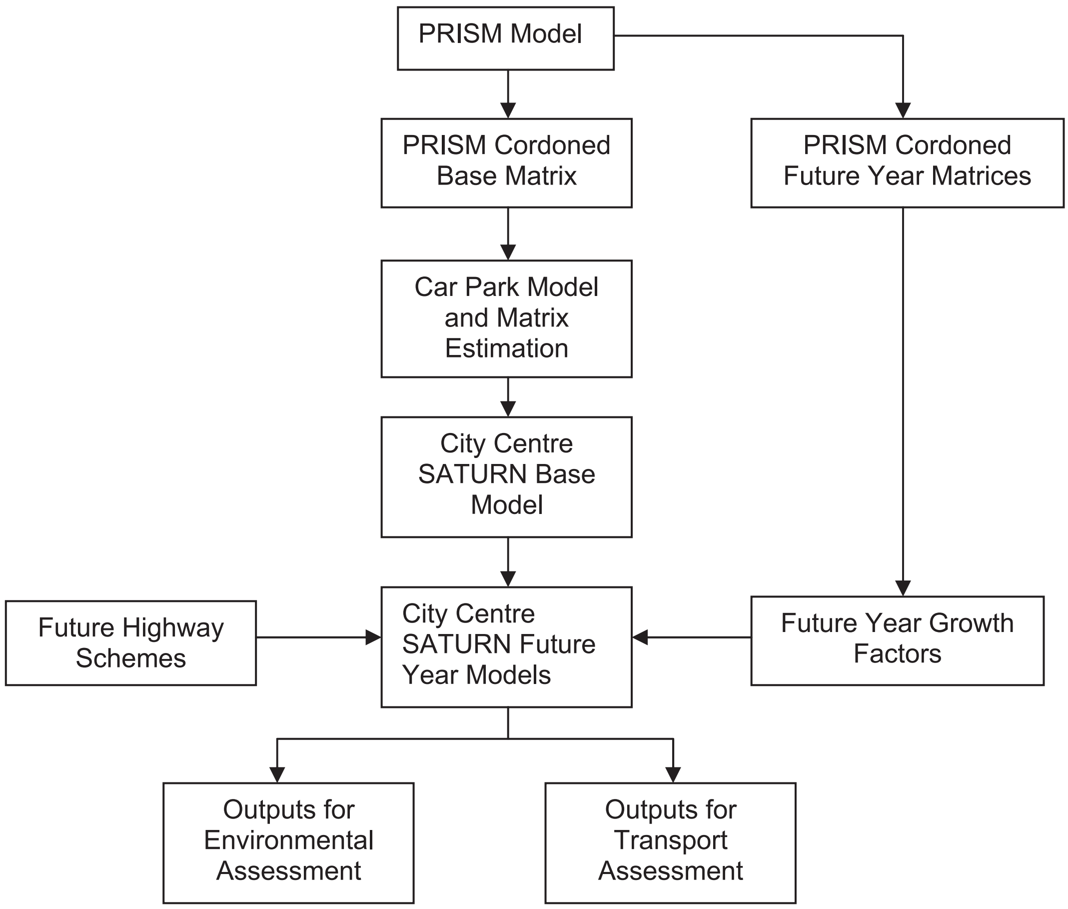
- Model purpose and connectivity with other models;
- Data collection for model update; and
- Matrix and network development for HS2 assessment.

The forecast models will be used to supply the following data;

- Environmental traffic flow data including Annual Average Daily Traffic Flows, proportion of HGVs, average link speed; and
- Link and turning traffic flows, average queues, delays, volume/capacities for use in the transport assessments.

Figure 2.1 shows the relationship between the City Centre SATURN model and other models, as well as key input and outputs.

Figure 2.1- SATURN Model Connectivity



2.1 Data Collection

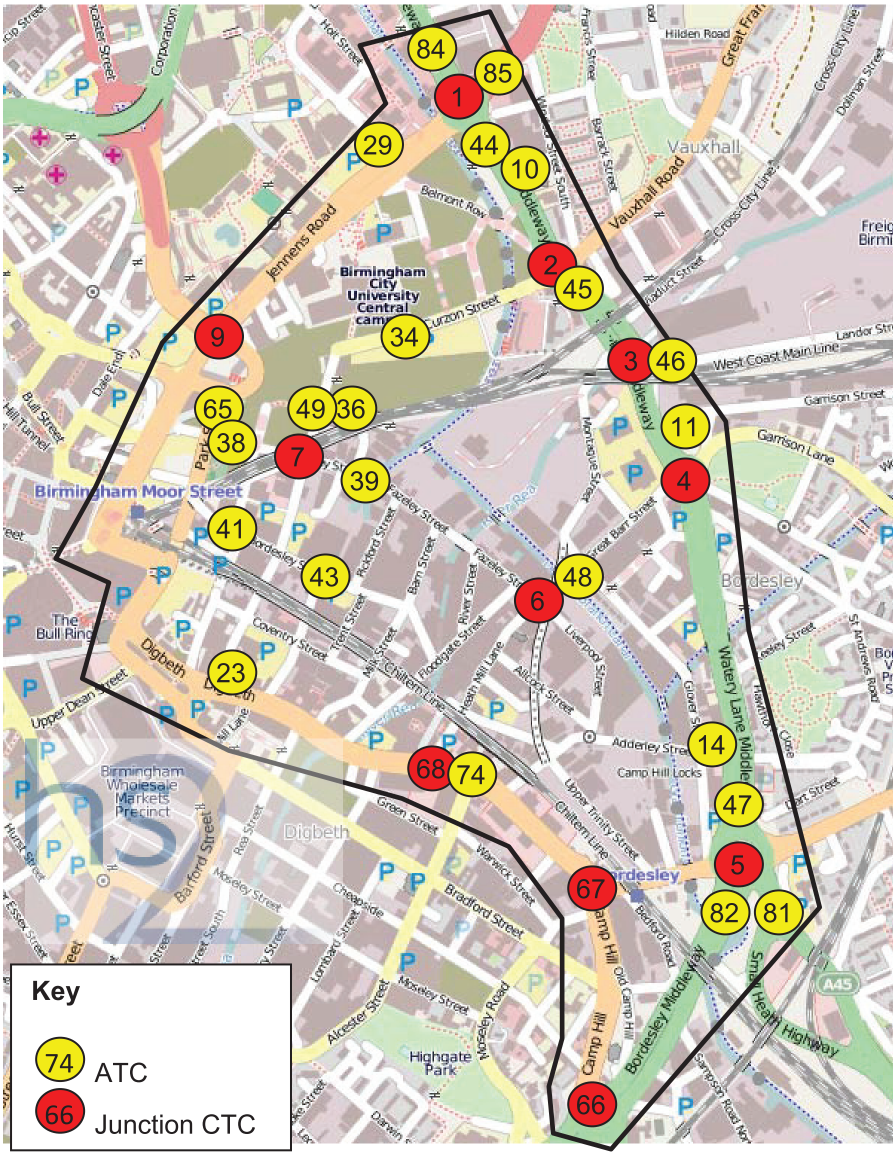
In order to update the 2012 base matrices and undertake logic checks on modelled flows and journey times, the following data has been supplied by Arup/Jacobs, collected in 2012 and 2013:

- Automated traffic counts on key roads;
- Classified turning counts at key junctions;
- Journey times for routes which include key roads, including:
    - Ring Road(A4540) between Dartmouth Circus and Camp Hill;
    - Digbeth and High Street Deritend;
    - Moor Street Queensway;
    - Park Street;
    - Jennens Road;
    - Curzon Street;
    - Fazeley Street; and

- Great Barr Street.

Figure 2.2 shows the location of traffic counts and the journey time routes are provided in Appendix C. The border shown in black represents the key study area for the HS2 assessment. It is noted, however, that the impact on traffic flows at Dartmouth Circus have also been considered.

Figure 2.2– Traffic Count Locations



2.2 Network Development

The 2012 model has been developed using SATURN version 10.9.24. As a combined simulation and assignment model SATURN is suitable for this study as it enables detailed junction modelling.

The model network has been updated as follows:

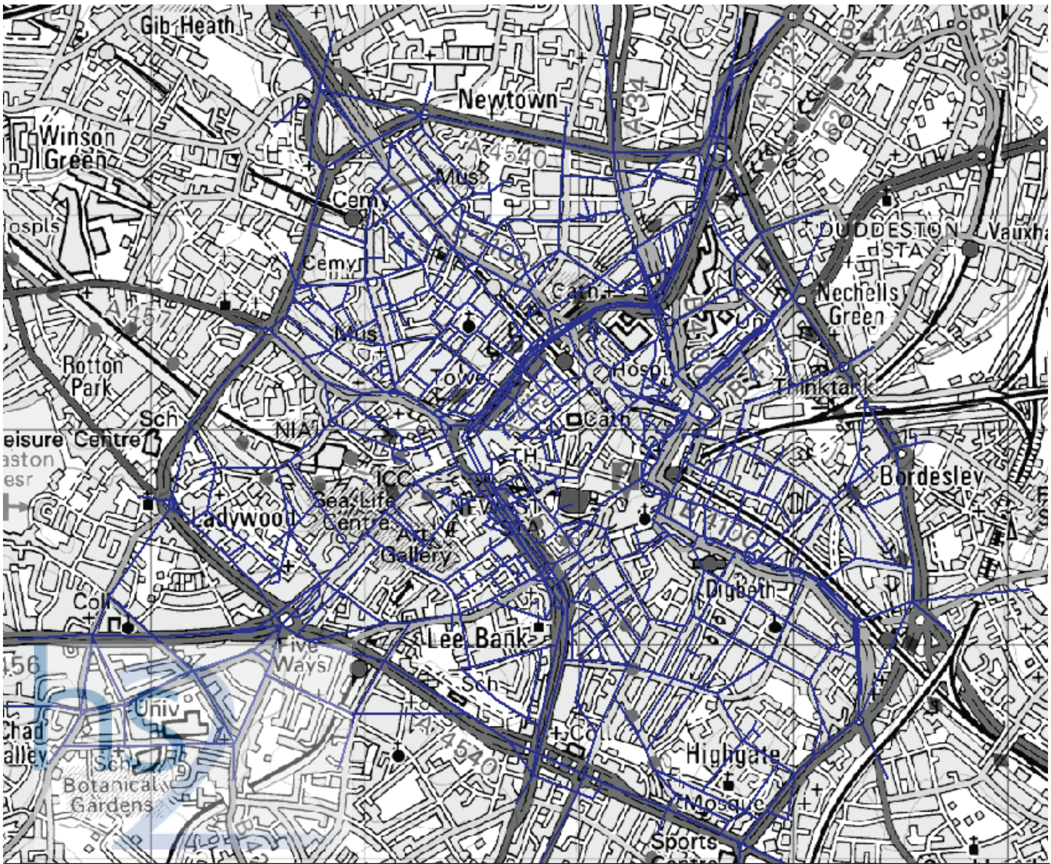
- Key network changes up to 2012 have been incorporated into the model, including:
  - St Chad's Circus;

- Ladywood Circus; and
- Moor Street Queensway.

- Signal timings and staging at all key junctions have been updated using signal plans provided by UTC and observations during the AM, Inter-Peak and PM peaks;
- Bus routes and frequencies have been updated to account for changes due to the City Centre Interchange scheme; and
- Additional network has been provided in the key study area to provide additional detail and routing options.

Figure 2.3 shows the model network, which is entirely simulation coding which enables detailed turning delays to be modelled.

Figure 2.3- SATURN Model Network



2.3 Matrix Development

The Birmingham City Centre SATURN model has 10 user classes based on vehicle type and journey purpose, as given in Table 2.1. These classes include vehicles which will park in car parks operated by either BCC or private operators such as NCP as well as separate matrices for trips using Private Non Residential (PNR) parking such as individual business private parking.

Table 2.1 - BCC SATURN Model User Classes

User Class	Description	User Class	Description
1	Car Park – Commuting	6	PNR – Business
2	Car Park – Business	7	PNR – Education
3	Car Park – Education	8	PNR – Other
4	Car Park – Other	9	Light Goods Vehicles (LGVs)
5	PNR – Commuting	10	Heavy Goods Vehicles (HGVs)

A Passenger Car Unit (PCU) factor of 1.0 has been applied to cars and LGVs and a factor of 2.0 has been applied to HGVs. A PCU factor of 3.0 has been applied to buses.

The zoning system used for the model is based on that used for the VISUM Model. The zone connector locations from the original model have been adjusted and the zones have been divided into the following three categories:

- Zones for Public Car Parks;
- Zones for Private Non Residential (PNR); and
- Blank zones for use in future modelling work.

Car parks have been explicitly modelled in order to better replicate traffic patterns around the city centre. The model zone areas are shown in Appendix A.

2.4 Matrix Development Methodology

Base year matrices have been developed using the following methodology:

- PRISM matrices have been supplied by Arup from the VISUM model, for the cordoned city centre area. The VISUM model is based on ultimate origins and destinations;
- Due to the removal of walking links and the subsequent relocation of zone connectors, the SATURN model is no longer based on ultimate origins and destinations. A car park model, therefore, has been used to identify the car parks (zones) which trips will use to reach their ultimate destination;
- The car park model takes into account the number of public, private and on-street parking spaces available within the zones and the cost of reaching the ultimate destination via the zone (including the value of time, fuel and non-fuel vehicle operating costs);
- The car park model has been calibrated and validated by comparing the modelled level of usage in the car parks with observed data during the AM peak hour. Although the volume of parking data available is limited, the model shows a reasonable 'goodness of fit'.

The trip matrices have been divided into 10 user classes as detailed in Table 2.1. Trips have been split between the Car Park zones and PNR zones based on the following assumptions:

- 20% of commuting trips will use car parks and 80% PNR zones;
- 100% of business trips will use PNR zones;
- 50% of education trips will use car parks and 50% will use PNR zones; and
- 100% of other journey purpose trips will use car parks.

Matrix estimation has been used to calibrate the 2012 base year matrices using the counts detailed in section 2. The matrix estimation process has been undertaken within SATURN using the SATME2 element of the program suite. The basic function of matrix estimation is to produce an updated matrix using traffic counts. Trips are adjusted in the matrix to produce an estimated matrix that is consistent with the traffic counts.

Figure 2.4 summarises the matrix development methodology process:

Figure 2.4 – Matrix Development Methodology

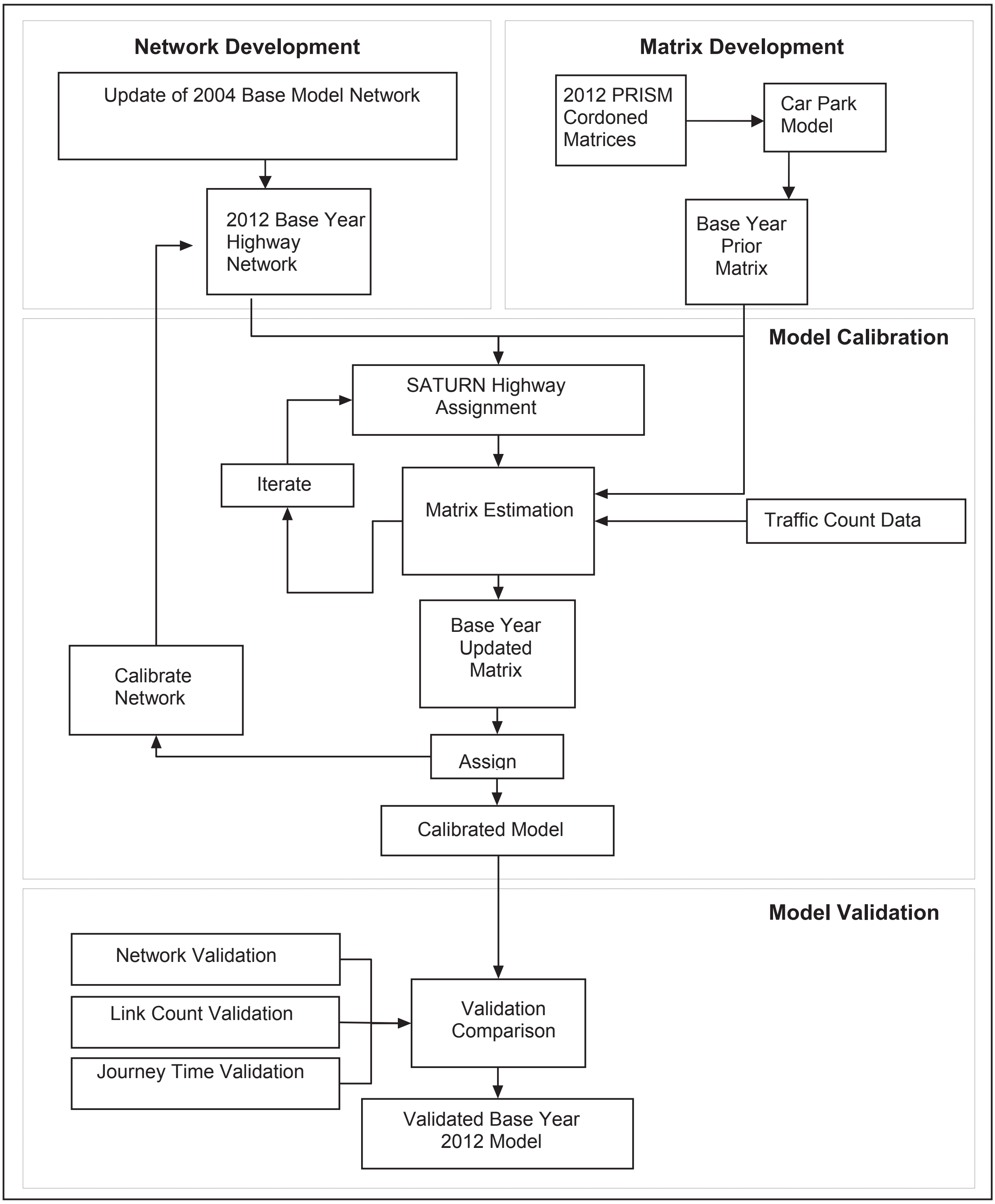


Table 2.2 shows the 2012 matrix totals in PCUS for each user class.

Table 2.2 – User Class Matrix Totals (PCUS)

User Class	Description	AM	IP	PM
1	Car Park – Commuting	4059	760	3333
2	Car Park – Business	0	0	0
3	Car Park – Education	1022	341	617
4	Car Park – Other	5518	17503	12364
5	PNR – Commuting	14635	3043	12781
6	PNR – Business	3222	5045	3735
7	PNR – Education	904	334	540
8	PNR – Other	0	0	0
9	Light Goods Vehicles	5456	3751	3387
10	Heavy Goods Vehicles	4900	5053	1740
Total		39715	35830	38498

3. Model Logic Check

3.1 Network convergence

The Highways Assignment Modelling guidance in WebTAG 3.19 recommends the following criteria for Wardrop User Equilibrium assignment to ensure a satisfactory model convergence:

- Delta – should be less than 0.1%, or at least stable, with convergence fully documented and all other criteria met. Delta is the measure of convergence of the final assignment to ensure that the alternative routes used in the assignment process do not differ significantly from the final minimum cost. It is the difference between costs on the various multiple assigned routes and those along the final minimum cost routes, as a percentage of minimum cost routes;
- Wardrop Equilibrium assignment percentage gap function should also be low at <0.05 for 4 consecutive loops; and
- Flow change (P) – should be less than 1% for four consecutive iterations for 98% of links. P is the measure of convergence of assignment-simulation loops. It is the percentage of links where assigned flows change by less than 1% between successive assignment-simulation loops.

Table 3.1 shows the last four iterations of the SATURN model convergence for each time period.

Table 3.1 –SATURN Convergence statistics

AM Peak Model Iteration	Delta (%)	% Gap	P < 1%
71	0.0328	0.037	99.7
72	0.0346	0.035	99.6
73	0.0292	0.042	100.0
74	0.0338	0.038	100.0

Inter Peak Model Iteration	Delta (%)	% Gap	P <1%
67	0.0199	0.036	100.0
68	0.0312	0.039	99.8
69	0.0269	0.029	99.9
70	0.0324	0.026	100.0

PM Peak Model Iteration	Delta (%)	% Gap	P < 1%
78	0.0418	0.042	99.7
79	0.0469	0.049	99.7
80	0.0446	0.044	99.7
81	0.0393	0.049	99.7

It can be observed from Table 3.1 that the model achieves the required levels of convergence for all time periods modelled.

3.2 Link Flows

Guidelines

The standard method for checking model calibration and validation is to compare observed values against modelled. For this comparison the acceptability guidelines are outlined in Highways Assignment Modelling Guidance in WebTAG 3.19 and summarised in Table 3.2.

One measure of the difference between observed and modelled flows presented in this note is GEH, which is a form of chi square test that incorporates both relative and absolute errors. The GEH formula is given below:

$$\text{GEH} = \sqrt{\frac{(M-C)^2}{\frac{(M+C)}{2}}}$$

Where:

GEH is the GEH statistic;

M is the modelled flow and

C is the observed flow.

Table 3.2 - Flow Comparison Guidelines

Criteria and measures for hourly flowscompared with observed flows	Acceptability guidelines
Individual flows with 15% for flows between 700 and 2,700 vph	> 85% of the cases
Individual flows within 100 vph for flows < 700 vph	
Individual flows within 400 vph for flows > 2,700 vph	
Total screenline flows (normally > 5 links) to be within 5%	All (or nearly all) screenlines
GEH statistic for individual flows: GEH <5	> 85% of the cases
GEH statistic for screenline totals: GEH <4	All (or nearly all) screenlines

Table 3.3 summarises the goodness of fit of the modelled traffic flows against the 2012 link counts based on the standard criteria set out WebTAG Unit 3.19. The tables provided in Appendix B show the goodness of fit for individual links. It can be observed that a good level of fit has been achieved on Curzon Street, which satisfies both the flow and GEH criteria during both the AM and PM peaks.

It should be noted that there are less counts for the Inter-Peak period as turning counts were not undertaken for this time period, which were used to derive link flows.

Table 3.3– Goodness of Fit of Link Flows

Criteria	AM Peak	Inter-Peak	PM Peak
Flow Criteria	83%	94%	81%
GEH < 5	77%	74%	77%
GEH < 8	89%	88%	85%

It can be observed from Table 3.3 that, within the key study area, over 81% of the links satisfy the flow criteria during all peaks.

Table 3.4 summarises the goodness of fit of modelled turning flows against Classified Turning Counts. It is noted that no turning count data was made available for the Inter Peak Period.

Table 3.4 – Goodness of Fit of Turning Flows

Criteria	AM Peak	Inter-Peak	PM Peak
Flow Criteria	78%	N/A	79%
GEH < 5	57%	N/A	55%
GEH < 8	77%	N/A	77%

It can be observed from Table 3.4 that, within the key study area, 78% of the modelled turning flows satisfy the DMRB criteria during the AM peak and 79% during the PM peak.

3.3 Journey Times

The DMRB recommends that for a ‘good fit’, modelled times should be within 15% (or 1 minute or lower) for 85% of routes.

A comparison has been undertaken between modelled and observed journey times, for seven routes in the key study area, shown in Appendix C, for the AM and PM peaks.

Tables 3.5 and 3.6 summarise the differences in overall journey times for each route, for the AM and PM peak hours respectively. It should be noted that this comparison has been based on journey times measured over the whole peak period for the AM (07:00-10:00) and PM (16:00-19:00) due to the limited number of journey time runs during the peak hour and the high level of variability.

Table 3.5– Journey Time Validation – AM Peak

Route No.	Route Description	Direction	Route Journey Time		Difference (sec)	Percentage Diff	Within 15% (or 60sec if higher)
			Observed	Modelled			
1	Curzon Street - Blue - Anticlockwise	NB	00:06:33	00:04:48	-105	-27%	×
2	Curzon Street - Blue - Anticlockwise	SB	00:08:32	00:09:35	63	12%	✓
3	Curzon Street - Blue - clockwise	NB	00:12:26	00:08:46	-220	-29%	×
4	Curzon Street - Blue - clockwise	SB	00:05:33	00:06:06	33	10%	✓
5	Curzon Street - Green - Anticlockwise	-	00:04:33	00:05:17	44	16%	✓
6	Curzon Street - Green - clockwise part 1	-	00:04:42	00:03:51	-51	-18%	✓
7	Curzon Street - Green - clockwise part 2	-	00:02:34	00:03:23	49	32%	✓

Table 3.6– Journey Time Validation – PM Peak

Route No.	Route Description	Direction	Route Journey Time		Difference (sec)	Percentage Diff	Within 15% (or 60sec if higher)
			Observed	Modelled			
1	Curzon Street - Blue - Anticlockwise	NB	00:08:34	00:05:41	-173	-34%	×
2	Curzon Street - Blue - Anticlockwise	SB	00:09:01	00:07:34	-87	-16%	×
3	Curzon Street - Blue - clockwise	NB	00:17:08	00:09:13	-475	-46%	×
4	Curzon Street - Blue - clockwise	SB	00:08:19	00:04:48	-211	-42%	×
5	Curzon Street - Green - Anticlockwise	-	00:06:14	00:05:21	-53	-14%	✓
6	Curzon Street - Green - clockwise part 1	-	00:04:37	00:03:56	-41	-15%	✓
7	Curzon Street - Green - clockwise part 2	-	00:02:59	00:03:22	23	13%	✓

It can be observed from Tables 3.5 and 3.6 that approximately 70% and 40% of the journey time routes have modelled journey times which are within 15% (or 60s if higher) of observed times during the AM and PM peaks respectively. In general, the modelled journey times are lower than

those observed, in particular on the Ring Road during the PM peak. It is noted, however, that the observed times have a high level of variability, even on consecutive runs.

The modelled journey times are similar to the lower 95th percentile observed journey times which demonstrates that the high level of queuing which can occur during fluctuations in traffic flow and due to other interactions, with pedestrian crossings for example, are not being represented within the model. Two locations where the model is underestimating delays are on the Watery Lane Middleway approach to Garrison Circus and the Dartmouth Middleway approach to Dartmouth Circus. It should be noted that SATURN does not model the blocking back of roundabouts which can cause significant delays in practice and may be occurring at Garrison Circus.

Further adjustment to improve the PM peak journey time validation was found to have adverse impacts on the AM peak and the traffic flow validation overall. As a result and as the model is being used for deriving traffic flow changes due to growth to 2026 and 2041 and the proposed scheme rather than detailed junction analysis, it was considered that no further adjustments should be applied.

It is also noted that as a significant number of improvement schemes are proposed for the Ring Road in the future year scenarios, it is not considered that the low level of journey time validation will have an impact on the future year assessments of HS2.

4. Summary

This note has outlined the logic check undertaken of the Birmingham City Centre SATURN model against the observed 2012 link and turn counts in the key study area around the HS2 site.

The model has been revised to reflect a 2012 base year based on the following:

- Network adjustments in line with the current position;
- Demand matrices supplied from the PRISM model.

The model adjustment and flow assessment has been undertaken in line the brief supplied.

In general, over 81% of the links assessed meet the standard fitness criteria specified in WebTAG in all time periods, and at a turn level the model achieves over 78% against the WebTAG criteria.

Whilst the journey time validation doesn’t meet accepted DMRB guidance, especially in the PM peak, the high levels of observed variability in the PM peak and the fact that the key junctions will be revised in the future year scenarios, due to improvement schemes, reduce the impact of this. Further, the model is being used for deriving traffic flow changes due to growth to 2026 and 2041 and the proposed scheme rather than for detailed junction delay analysis.

Overall it is considered that the model provides a reasonable platform for the strategic highway assessment of the HS2 station development in Birmingham City Centre and for deriving changes in traffic flow due to growth to 2026 and 2041 and the proposed scheme.

Appendix A

Figure Error! No text of specified style in document.**.1 – Zone Plan**

Appendix B

AM Peak Link Flows

Location	Movement	Ref	Observed			Modelled			% Difference	Absolute Difference	Total GEH	DMRB Guidance	
			Lights	Heavies	Total	Lights	Heavies	Total				Flow	GEH
Garrison Street	WB	11 WB	16	15	31	92	10	101	227.1%	70	9	✓	×
Adderley Street	EB	14 EB	19	4	23	0	0	0	-99.8%	-23	7	✓	×
Adderley Street	WB	14 WB	72	7	79	120	7	127	60.9%	48	5	✓	✓
Meriden Street	NB	23 NB	62	8	70	54	5	59	-15.3%	-11	1	✓	✓
Meriden Street	SB	23 SB	85	24	109	0	0	0	-100.0%	-109	15	×	×
Woodcock Street	NB	29 NB	126	11	137	118	28	146	6.6%	9	1	✓	✓
Woodcock Street	SB	29 SB	51	3	54	52	29	81	50.2%	27	3	✓	✓
Curzon Street	EB	34 EB	172	21	193	144	13	157	-18.7%	-36	3	✓	✓
Curzon Street	WB	34 WB	201	33	234	209	17	226	-3.2%	-8	0	✓	✓
Banbury Street	EB	36 EB	12	1	13	61	3	64	394.0%	51	8	✓	×
Banbury Street	WB	36 WB	10	2	12	54	2	56	367.1%	44	8	✓	×
Fazeley Street east of park street	EB	38 EB	216	18	234	186	18	204	-12.9%	-30	2	✓	✓
Fazeley Street east of park street	WB	38 WB	64	7	71	64	5	69	-2.6%	-2	0	✓	✓
Fazeley Street	EB	39 EB	176	13	189	146	14	160	-15.3%	-29	2	✓	✓
Fazeley Street	WB	39 WB	143	12	155	84	5	89	-42.9%	-66	6	✓	×
Bordesley Street	EB	41 EB	91	7	97	67	5	71	-26.7%	-26	3	✓	✓
Bordesley Street	WB	41 WB	14	2	16	0	0	0	-100.0%	-16	6	✓	×
A4540	NB	44A NB	1331	199	1530	1323	192	1515	-1.0%	-15	0	✓	✓
A4540 south of Ashted Circus Junction A47/A4540	SB	44B SB	1694	149	1843	1587	187	1775	-3.7%	-68	2	✓	✓
A4540 south of Curzon Circle Junction	NB	45 NB	1802	187	1989	1802	174	1975	-0.7%	-14	0	✓	✓
A4540 south of Curzon Circle Junction	SB	45 SB	1517	316	1833	1769	227	1996	8.9%	163	4	✓	✓
Landor Street	EB	46 EB	136	35	171	136	21	157	-7.9%	-14	1	✓	✓
Landor Street	WB	46 WB	320	74	394	318	8	326	-17.3%	-68	4	✓	✓
A4540 Bordesley Circus Junction A45	NB	47 NB	1525	101	1626	1672	137	1809	11.2%	183	4	✓	✓
A4540 Bordesley Circus Junction A45	SB	47 SB	1566	134	1700	1526	165	1691	-0.5%	-9	0	✓	✓
Great Barr Street	NB	48 NB	249	54	303	200	46	246	-18.9%	-57	3	✓	✓
Great Barr Street	SB	48 SB	391	54	445	383	58	441	-0.8%	-4	0	✓	✓
New Canal Street	NB	49 NB	192	11	203	167	12	179	-11.8%	-24	2	✓	✓
New Canal Street	SB	49 SB	240	7	247	225	16	240	-2.7%	-7	0	✓	✓
Park Street	SB	65 SB	879	44	923	900	97	997	8.0%	74	2	✓	✓
High Street	EB	74A EB	362	90	452	383	128	512	13.2%	60	3	✓	✓
High Street	WB	74A WB	914	84	998	815	108	923	-7.5%	-75	2	✓	✓
Fazeley Street	EB	79 EB	208	17	225	186	18	204	-9.4%	-21	1	✓	✓
Fazeley Street	WB	79 WB	93	4	97	64	5	69	-28.7%	-28	3	✓	✓

Location	Movement	Ref	Observed			Modelled			% Difference	Absolute Difference	Total GEH	DMRB Guidance	
			Lights	Heavies	Total	Lights	Heavies	Total				Flow	GEH
A45 south of Bordesley Circus Junction	NB	81 NB	1013	112	1125	961	112	1073	-4.6%	-52	2	✓	✓
A45 south of Bordesley Circus Junction	SB	81 SB	1053	148	1200	1057	115	1171	-2.4%	-29	1	✓	✓
A4540 south of Bordesley Circus Junction	NB	82A NB	1457	65	1522	1435	75	1510	-0.8%	-12	0	✓	✓
A4540	SB	82B SB	993	148	1141	1195	138	1332	16.8%	191	5	✗	✗
A4540	NB	84 NB	1175	128	1303	1164	154	1318	1.2%	15	0	✓	✓
A4540	SB	84 SB	1344	174	1518	1517	150	1667	9.8%	149	4	✓	✓
A47 east of Ashted Circus Junction A47/A4540	EB	85 EB	418	92	510	419	109	528	3.5%	18	1	✓	✓
A47 east of Ashted Circus Junction A47/A4540	WB	85 WB	672	96	768	669	91	759	-1.1%	-9	0	✓	✓
Jennens Road EB	EB	CS1	308	48	356	245	62	308	-13.6%	-48	3	✓	✓
Jennens Road WB	WB	CS1	578	63	641	583	45	628	-2.1%	-13	1	✓	✓
New Canal Street, north of Banbury St, SB	SB	CS36	220	12	232	209	17	226	-2.4%	-6	0	✓	✓
New Canal Street, north of Banbury St, NB	NB	CS36	175	12	187	144	13	157	-16.1%	-30	2	✓	✓
Coventry Road, West of Bordesley Circus, NB	NB	CS5	219	48	267	311	86	397	48.7%	130	7	✗	✗
Coventry Road, West of Bordesley Circus, SB	SB	CS5	444	42	486	481	73	554	14.0%	68	3	✓	✓
Coventry Road, East of Bordesley Circus, WB	WB	CS5	704	53	757	642	81	723	-4.5%	-34	1	✓	✓
Coventry Road, East of Bordesley Circus, EB	EB	CS5	686	62	748	471	57	528	-29.4%	-220	9	✗	✗
Camp Hill SB	SB	CS66	308	60	368	315	97	412	12.0%	44	2	✓	✓
Camp Hill NB	NB	CS66	805	57	862	632	69	701	-18.7%	-161	6	✗	✗
Highgate Middleway NB	NB	CS66	1295	67	1362	1262	58	1320	-3.1%	-42	1	✓	✓
Highgate Middleway SB	SB	CS66	1422	77	1499	1024	61	1085	-27.6%	-414	12	✗	✗
Stratford Road NB	NB	CS66	910	70	980	913	113	1026	4.7%	46	1	✓	✓
Stratford Road SB	SB	CS66	594	82	676	595	201	796	17.8%	120	4	✗	✓
Curzon Street EB	EB	CS2	147	12	159	135	12	147	-7.6%	-12	1	✓	✓
Curzon Street WB	WB	CS2	273	15	288	263	16	279	-3.0%	-9	1	✓	✓
Vauxhall Road WB	WB	CS2	535	63	598	535	63	598	0.0%	0	0	✓	✓
Vauxhall Road EB	EB	CS2	575	72	647	580	13	593	-8.4%	-54	2	✓	✓
Aston Road, North of Junction, SB	SB	CS103	1910	164	2074	1891	200	2091	0.8%	17	0	✓	✓
Aston Road, North of Junction, NB	NB	CS103	1197	170	1367	1249	178	1427	4.4%	60	2	✓	✓
Newtown Middleway EB	EB	CS103	1305	110	1415	1191	102	1294	-8.6%	-121	3	✓	✓
Newtown Middleway WB	WB	CS103	1449	103	1552	1411	114	1525	-1.7%	-27	1	✓	✓
Aston Road, South of Junction, NB	NB	CS103	684	52	736	650	78	728	-1.2%	-9	0	✓	✓
Aston Road, South of Junction, SB	SB	CS103	841	68	909	977	118	1094	20.4%	185	6	✗	✗
Dartmouth Middleway WB	WB	CS103	1313	156	1469	1268	171	1439	-2.0%	-30	1	✓	✓
Dartmouth Middleway EB	EB	CS103	1725	141	1866	1352	139	1491	-20.1%	-375	9	✗	✗

Location	Movement	Ref	Observed			Modelled			% Difference	Absolute Difference	Total GEH	DMRB Guidance	
			Lights	Heavies	Total	Lights	Heavies	Total				Flow	GEH
Lawley Middleway, north of Garrison Circus, SB	SB	CS4	2281	216	2497	2034	223	2258	-9.6%	-239	5	✓	✓
Lawley Middleway, north of Garrison Circus, NB	NB	CS4	1828	152	1980	1787	173	1960	-1.0%	-20	0	✓	✓
Great Barr Street EB	EB	CS4	222	38	260	212	50	262	0.6%	2	0	✓	✓
Great Barr Street WB	WB	CS4	489	52	541	500	56	556	2.7%	15	1	✓	✓
Watery Lane Middleway NB	NB	CS4	1526	125	1651	1538	130	1668	1.0%	17	0	✓	✓
Watery Lane Middleway SB	SB	CS4	1869	181	2050	1526	165	1691	-17.5%	-359	8	✗	✗
Garrison Lane WB	WB	CS4	519	57	576	397	48	444	-22.9%	-132	6	✗	✗
Garrison Lane EB	EB	CS4	362	51	413	364	57	421	2.0%	8	0	✓	✓
Fazeley Street SB	SB	CS6	101	18	119	134	22	156	30.8%	37	3	✓	✓
Fazeley Street NB	NB	CS6	284	13	297	155	13	168	-43.3%	-129	8	✗	✗
Heath Mill Lane NB	NB	CS6	288	39	327	94	7	101	-69.2%	-226	15	✗	✗
Heath Mill Lane SB	SB	CS6	303	39	342	305	43	348	1.7%	6	0	✓	✓
Liverpool Street NB	NB	CS6	50	9	59	104	5	108	83.7%	49	5	✓	✗
Liverpool Street SB	SB	CS6	32	9	41	31	2	33	-19.7%	-8	1	✓	✓
High Street Bordesley SB	SB	CS67	407	90	497	453	144	597	20.1%	100	4	✗	✓
High Street Bordesley NB	NB	CS67	871	66	937	846	112	959	2.3%	22	1	✓	✓
Camp Hill NB	NB	CS67	465	24	489	428	42	470	-3.8%	-19	1	✓	✓
Camp Hill SB	SB	CS67	219	37	256	205	61	266	3.8%	10	1	✓	✓
Heath Mill Lane SB	SB	CS68	273	48	321	268	43	311	-3.0%	-10	1	✓	✓
Heath Mill Lane NB	NB	CS68	316	41	357	261	7	268	-24.8%	-89	5	✓	✗
High Street Deritend, west of Heath Mill Lane, EB	EB	CS68	305	93	398	357	134	491	23.4%	93	4	✓	✓
High Street Deritend, west of Heath Mill Lane, WB	WB	CS68	814	94	908	796	149	945	4.1%	37	1	✓	✓
High Street Deritend, east of Heath Mill Lane, WB	WB	CS68	914	84	998	815	108	923	-7.5%	-75	2	✓	✓
Lister Street EB	EB	CS104	81	8	89	104	40	144	61.2%	55	5	✓	✗
Lister Street WB	WB	CS104	284	9	293	86	29	115	-60.9%	-178	13	✗	✗
Dartmouth Middleway, south of Lister St, NB	NB	CS104	1118	126	1244	1164	154	1318	6.0%	74	2	✓	✓
Dartmouth Middleway, south of Lister St, SB	SB	CS104	1571	140	1711	1517	150	1667	-2.6%	-44	1	✓	✓
Great Lister Street WB	WB	CS104	372	27	399	372	48	420	5.3%	21	1	✓	✓
Great Lister Street EB	EB	CS104	122	10	132	122	31	153	15.8%	21	2	✓	✓
James Watt Queensway SB	SB	CS9	913	32	945	1001	158	1159	22.7%	214	7	✗	✗
James Watt Queensway NB	NB	CS9	449	69	518	455	69	523	1.0%	5	0	✓	✓
Moor Street Queensway EB	EB	CS9	695	191	886	607	154	761	-14.1%	-125	4	✓	✓
Jennens Road WB	WB	CS9	333	57	390	167	63	229	-41.2%	-161	9	✗	✗
Jennens Road EB	EB	CS9	455	58	513	242	79	321	-37.4%	-192	9	✗	✗
Chapel Street SB	SB	CS9	1037	153	1190	1016	205	1221	2.6%	31	1	✓	✓
New Canal Street, south of Fazeley Street, NB	NB	CS7	96	8	104	91	8	99	-4.6%	-5	0	✓	✓
New Canal Street, south of Fazeley Street, SB	SB	CS7	216	15	231	209	15	224	-3.2%	-7	0	✓	✓

PM Peak Link Flows

Location	Movement	Ref	Observed			Modelled			% Difference	Absolute Difference	Total GEH	DMRB Guidance	
			Lights	Heavies	Total	Lights	Heavies	Total				Flow	GEH
Garrison Street	WB	11 WB	80	4	84	80	2	82	-3.0%	-2	0	✓	✓
Adderley Street	EB	14 EB	60	3	63	0	0	0	-100.0%	-63	11	✓	✗
Adderley Street	WB	14 WB	104	6	110	110	3	113	3.0%	3	0	✓	✓
Meriden Street	NB	23 NB	69	6	75	53	1	54	-28.0%	-21	3	✓	✓
Meriden Street	SB	23 SB	217	8	225	0	0	0	-100.0%	-225	21	✗	✗
Woodcock Street	NB	29 NB	131	6	137	86	19	105	-23.5%	-32	3	✓	✓
Woodcock Street	SB	29 SB	61	2	63	147	18	165	161.5%	102	10	✗	✗
Curzon Street	EB	34 EB	387	18	405	413	3	416	2.7%	11	1	✓	✓
Curzon Street	WB	34 WB	198	11	209	153	1	154	-26.4%	-55	4	✓	✓
Banbury Street	EB	36 EB	9	1	10	59	1	60	498.4%	50	8	✓	✗
Banbury Street	WB	36 WB	23	1	24	49	1	50	107.4%	26	4	✓	✓
Fazeley Street east of park street	EB	38 EB	268	11	279	276	4	280	0.4%	1	0	✓	✓
Fazeley Street east of park street	WB	38 WB	85	5	90	114	2	116	29.3%	26	3	✓	✓
Fazeley Street	EB	39 EB	231	7	238	139	2	140	-41.0%	-98	7	✓	✗
Fazeley Street	WB	39 WB	206	10	216	122	3	124	-42.4%	-92	7	✓	✗
Bordesley Street	EB	41 EB	84	7	91	75	3	78	-14.1%	-13	1	✓	✓
Bordesley Street	WB	41 WB	31	3	33	0	0	0	-100.0%	-33	8	✓	✗
A4540	NB	44A NB	1564	132	1696	1522	42	1564	-7.8%	-132	3	✓	✓
A4540 south of Ashted Circus Junction A47/A4540	SB	44B SB	1366	64	1430	1372	33	1404	-1.8%	-26	1	✓	✓
A4540 south of Curzon Circle Junction	NB	45 NB	2151	80	2231	1821	32	1853	-16.9%	-378	8	✗	✗
A4540 south of Curzon Circle Junction	SB	45 SB	1447	155	1602	1675	35	1710	6.7%	108	3	✓	✓
Landor Street	EB	46 EB	192	25	217	36	2	38	-82.5%	-179	16	✗	✗
Landor Street	WB	46 WB	239	29	268	238	2	239	-10.7%	-29	2	✓	✓
A4540 Bordesley Circus Junction A45	NB	47 NB	1311	23	1334	1236	18	1255	-6.0%	-79	2	✓	✓
A4540 Bordesley Circus Junction A45	SB	47 SB	1367	21	1388	1408	26	1433	3.3%	45	1	✓	✓
Great Barr Street	NB	48 NB	444	34	478	439	16	455	-4.9%	-23	1	✓	✓
Great Barr Street	SB	48 SB	336	25	361	349	14	363	0.5%	2	0	✓	✓
New Canal Street	NB	49 NB	307	2	309	393	3	397	28.4%	88	5	✓	✓
New Canal Street	SB	49 SB	129	1	130	124	1	125	-4.2%	-5	0	✓	✓
Park Street	SB	65 SB	829	35	864	815	52	867	0.3%	3	0	✓	✓
High Street	EB	74A EB	1068	53	1121	954	83	1038	-7.4%	-83	3	✓	✓
High Street	WB	74A WB	858	73	931	505	77	582	-37.4%	-349	13	✗	✗
Fazeley Street	EB	79 EB	268	7	275	276	4	280	1.9%	5	0	✓	✓
Fazeley Street	WB	79 WB	121	2	123	114	2	116	-5.4%	-7	1	✓	✓

Location	Movement	Ref	Observed			Modelled			% Difference	Absolute Difference	Total GEH	DMRB Guidance	
			Lights	Heavies	Total	Lights	Heavies	Total				Flow	GEH
A45 south of Bordesley Circus Junction	NB	81 NB	1063	86	1149	1051	43	1094	-4.8%	-55	2	✓	✓
A45 south of Bordesley Circus Junction	SB	81 SB	1361	99	1459	1361	31	1392	-4.6%	-67	2	✓	✓
A4540 south of Bordesley Circus Junction	NB	82A NB	1441	31	1472	1386	22	1408	-4.3%	-64	2	✓	✓
A4540	SB	82B SB	1238	79	1317	1261	47	1308	-0.7%	-9	0	✓	✓
A4540	NB	84 NB	1523	40	1563	1474	18	1492	-4.5%	-71	2	✓	✓
A4540	SB	84 SB	1095	115	1210	1315	32	1347	11.3%	137	4	✓	✓
A47 east of Ashted Circus Junction A47/A4540	EB	85 EB	628	63	691	625	44	668	-3.3%	-23	1	✓	✓
A47 east of Ashted Circus Junction A47/A4540	WB	85 WB	509	52	561	509	41	550	-2.0%	-11	0	✓	✓
Jennens Road EB	EB	CS1	524	47	571	514	21	535	-6.3%	-36	2	✓	✓
Jennens Road WB	WB	CS1	363	42	405	390	40	431	6.4%	26	1	✓	✓
New Canal Street, north of Banbury St, SB	SB	CS36	213	0	213	153	1	154	-27.8%	-59	4	✓	✓
New Canal Street, north of Banbury St, NB	NB	CS36	484	5	489	413	3	416	-14.9%	-73	3	✓	✓
Coventry Road, West of Bordesley Circus, NB	NB	CS5	499	33	532	477	52	529	-0.6%	-3	0	✓	✓
Coventry Road, West of Bordesley Circus, SB	SB	CS5	522	37	559	504	48	553	-1.1%	-6	0	✓	✓
Coventry Road, East of Bordesley Circus, WB	WB	CS5	703	23	726	696	45	741	2.1%	15	1	✓	✓
Coventry Road, East of Bordesley Circus, EB	EB	CS5	694	33	727	655	43	698	-3.9%	-29	1	✓	✓
CPMp Hill SB	SB	CS66	1020	55	1075	814	51	865	-19.6%	-210	7	✗	✗
CPMp Hill NB	NB	CS66	458	56	514	380	62	442	-14.0%	-72	3	✓	✓
Highgate Middleway NB	NB	CS66	1482	40	1522	1448	19	1467	-3.6%	-55	1	✓	✓
Highgate Middleway SB	SB	CS66	1307	14	1321	1269	36	1305	-1.2%	-16	0	✓	✓
Stratford Road NB	NB	CS66	548	71	619	543	70	614	-0.8%	-5	0	✓	✓
Stratford Road SB	SB	CS66	970	64	1034	1031	67	1098	6.2%	64	2	✓	✓
Curzon Street EB	EB	CS2	557	7	564	467	3	470	-16.6%	-94	4	✓	✓
Curzon Street WB	WB	CS2	174	4	178	165	1	166	-6.9%	-12	1	✓	✓
Vauxhall Road WB	WB	CS2	492	17	509	491	9	500	-1.8%	-9	0	✓	✓
Vauxhall Road EB	EB	CS2	804	49	853	797	12	809	-5.1%	-44	2	✓	✓
Aston Road, North of Junction, SB	SB	CS103	1302	73	1375	1302	67	1369	-0.5%	-6	0	✓	✓
Aston Road, North of Junction, NB	NB	CS103	1999	68	2067	2049	75	2123	2.7%	56	1	✓	✓
Newtown Middleway EB	EB	CS103	1380	43	1423	1424	33	1457	2.4%	34	1	✓	✓
Newtown Middleway WB	WB	CS103	1682	34	1716	1105	11	1116	-34.9%	-600	16	✗	✗
Aston Road, South of Junction, NB	NB	CS103	911	33	944	1025	52	1077	14.1%	133	4	✓	✓
Aston Road, South of Junction, SB	SB	CS103	644	25	669	797	50	847	26.6%	178	6	✗	✗
Dartmouth Middleway WB	WB	CS103	2080	36	2116	1626	18	1644	-22.3%	-472	11	✗	✗
Dartmouth Middleway EB	EB	CS103	1348	58	1406	1304	30	1334	-5.1%	-72	2	✓	✓

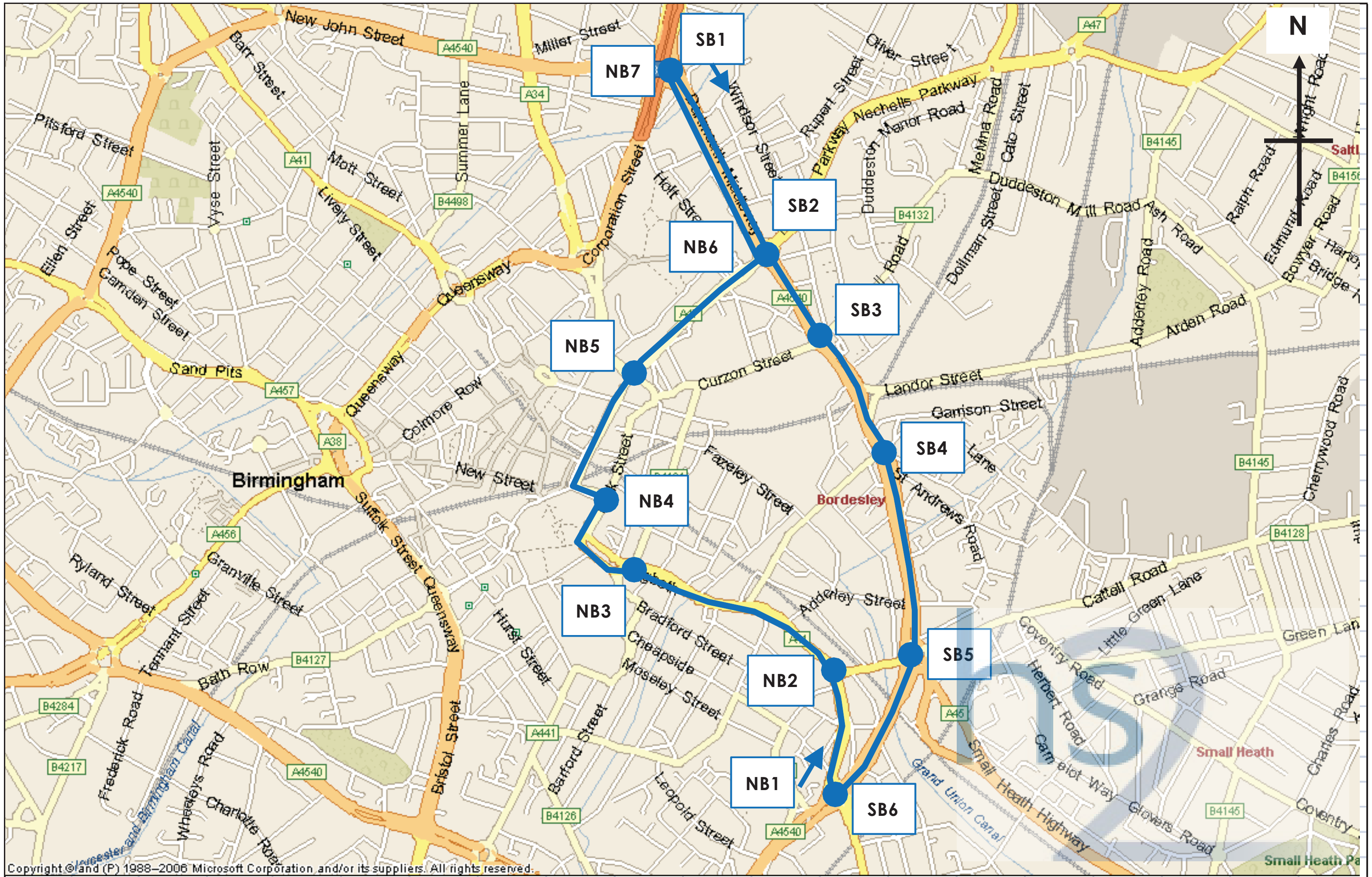
Location	Movement	Ref	Observed			Modelled			% Difference	Absolute Difference	Total GEH	DMRB Guidance	
			Lights	Heavies	Total	Lights	Heavies	Total				Flow	GEH
Lawley Middleway, north of Garrison Circus, SB	SB	CS4	2026	72	2098	1956	37	1993	-5.0%	-105	2	✓	✓
Lawley Middleway, north of Garrison Circus, NB	NB	CS4	1705	62	1767	1631	31	1662	-6.0%	-105	3	✓	✓
Great Barr Street EB	EB	CS4	554	32	586	547	19	567	-3.3%	-19	1	✓	✓
Great Barr Street WB	WB	CS4	453	27	480	471	16	487	1.4%	7	0	✓	✓
Watery Lane Middleway NB	NB	CS4	1135	34	1169	1081	15	1096	-6.2%	-73	2	✓	✓
Watery Lane Middleway SB	SB	CS4	1532	42	1574	1408	26	1433	-8.9%	-141	4	✓	✓
Garrison Lane WB	WB	CS4	522	26	548	475	12	487	-11.2%	-61	3	✓	✓
Garrison Lane EB	EB	CS4	547	33	580	547	11	558	-3.8%	-22	1	✓	✓
Fazeley Street SB	SB	CS6	368	12	380	362	6	368	-3.1%	-12	1	✓	✓
Fazeley Street NB	NB	CS6	160	16	176	158	8	166	-5.6%	-10	1	✓	✓
Heath Mill Lane NB	NB	CS6	377	41	418	127	3	130	-68.8%	-288	17	✗	✗
Heath Mill Lane SB	SB	CS6	362	35	397	320	5	325	-18.1%	-72	4	✓	✓
Liverpool Street NB	NB	CS6	97	9	106	107	2	110	3.5%	4	0	✓	✓
Liverpool Street SB	SB	CS6	129	11	140	126	1	127	-9.4%	-13	1	✓	✓
High Street Bordesley SB	SB	CS67	1189	58	1247	1191	88	1279	2.6%	32	1	✓	✓
High Street Bordesley NB	NB	CS67	731	62	793	527	80	606	-23.5%	-187	7	✗	✗
CPMp Hill NB	NB	CS67	310	26	336	145	32	177	-47.3%	-159	10	✗	✗
CPMp Hill SB	SB	CS67	816	20	836	837	37	874	4.6%	38	1	✓	✓
Heath Mill Lane SB	SB	CS68	203	6	209	261	5	266	27.3%	57	4	✓	✓
Heath Mill Lane NB	NB	CS68	364	37	401	50	3	53	-86.7%	-348	23	✗	✗
High Street Deritend, west of Heath Mill Lane, EB	EB	CS68	920	64	984	918	86	1004	2.0%	20	1	✓	✓
High Street Deritend, west of Heath Mill Lane, WB	WB	CS68	549	53	602	679	82	761	26.4%	159	6	✗	✗
High Street Deritend, east of Heath Mill Lane, WB	WB	CS68	858	73	931	505	77	582	-37.4%	-349	13	✗	✗
Lister Street EB	EB	CS104	361	7	368	245	21	266	-27.7%	-102	6	✗	✗
Lister Street WB	WB	CS104	136	5	141	64	20	83	-40.9%	-58	5	✓	✗
Dartmouth Middleway, south of Lister St, NB	NB	CS104	1737	43	1780	1474	18	1492	-16.2%	-288	7	✗	✗
Dartmouth Middleway, south of Lister St, SB	SB	CS104	1205	61	1266	1315	32	1347	6.4%	81	2	✓	✓
Great Lister Street WB	WB	CS104	272	8	280	272	23	295	5.4%	15	1	✓	✓
Great Lister Street EB	EB	CS104	291	7	298	291	23	313	5.2%	15	1	✓	✓
JPMes Watt Queensway SB	SB	CS9	1004	21	1025	676	83	758	-26.0%	-267	9	✗	✗
JPMes Watt Queensway NB	NB	CS9	555	63	618	596	35	630	2.0%	12	0	✓	✓
Moor Street Queensway EB	EB	CS9	844	171	1015	839	107	946	-6.8%	-69	2	✓	✓
Jennens Road WB	WB	CS9	368	43	411	458	56	515	25.2%	104	5	✗	✓
Jennens Road EB	EB	CS9	406	50	456	251	38	289	-36.5%	-167	9	✗	✗
Chapel Street SB	SB	CS9	1255	122	1377	1098	171	1269	-7.8%	-108	3	✓	✓
New Canal Street, south of Fazeley Street, NB	NB	CS7	288	3	291	361	2	364	24.9%	73	4	✓	✓
New Canal Street, south of Fazeley Street, SB	SB	CS7	232	1	233	237	2	239	2.6%	6	0	✓	✓

Inter-Peak Link Flows

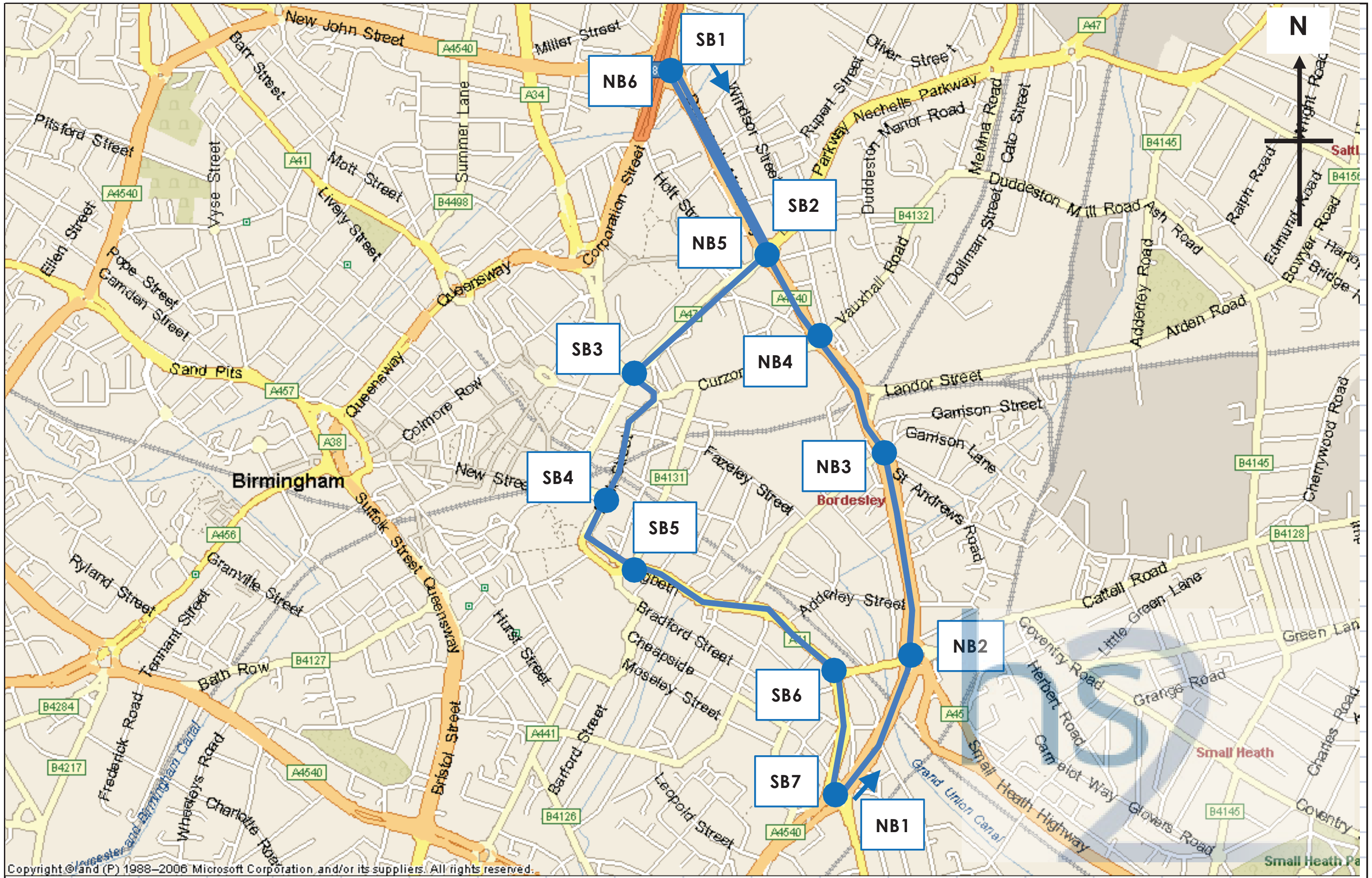
Location	Movement	Ref	Observed			Modelled			% Difference	Absolute Difference	Total GEH	DMRB Guidance	
			Lights	Heavies	Total	Lights	Heavies	Total				Flow	GEH
Garrison Street	WB	11 WB	74	16	90	71	9	80	-11.1%	-10	1	✓	✓
Adderley Street	EB	14 EB	63	9	72	0	0	0	-100.0%	-72	12	✓	✗
Adderley Street	WB	14 WB	96	11	107	94	11	105	-1.5%	-2	0	✓	✓
Meriden Street	NB	23 NB	58	8	65	53	4	57	-12.0%	-8	1	✓	✓
Meriden Street	SB	23 SB	118	17	135	0	0	0	-100.0%	-135	16	✗	✗
Woodcock Street	NB	29 NB	64	11	76	5	19	24	-68.5%	-52	7	✓	✗
Woodcock Street	SB	29 SB	39	3	42	86	41	127	201.3%	85	9	✓	✗
Curzon Street	EB	34 EB	249	30	279	229	18	247	-11.3%	-31	2	✓	✓
Curzon Street	WB	34 WB	153	23	176	150	20	170	-3.6%	-6	0	✓	✓
Banbury Street	EB	36 EB	11	1	12	40	12	52	335.3%	40	7	✓	✗
Banbury Street	WB	36 WB	14	2	16	2	0	2	-87.3%	-14	5	✓	✓
Fazeley Street east of park street	EB	38 EB	193	20	213	179	18	198	-7.0%	-15	1	✓	✓
Fazeley Street east of park street	WB	38 WB	87	7	93	85	9	94	0.4%	0	0	✓	✓
Fazeley Street	EB	39 EB	157	15	172	109	16	124	-27.7%	-48	4	✓	✓
Fazeley Street	WB	39 WB	151	18	169	100	9	108	-35.9%	-61	5	✓	✗
Bordesley Street	EB	41 EB	66	7	73	172	8	180	146.9%	107	10	✗	✗
Bordesley Street	WB	41 WB	26	2	28	0	0	0	-100.0%	-28	7	✓	✗
A4540	NB	44A NB	1272	269	1542	1285	270	1554	0.8%	13	0	✓	✓
A4540 south of Curzon Circle Junction	SB	45 SB	1282	329	1611	1296	327	1623	0.8%	12	0	✓	✓
Landor Street	EB	46 EB	165	57	222	112	29	140	-36.7%	-81	6	✓	✗
Landor Street	WB	46 WB	230	60	290	230	22	252	-13.3%	-38	2	✓	✓
Great Barr Street	NB	48 NB	301	69	369	290	71	362	-2.1%	-8	0	✓	✓
Great Barr Street	SB	48 SB	301	47	347	238	51	289	-16.8%	-58	3	✓	✓
New Canal Street	NB	49 NB	345	9	354	252	20	273	-23.0%	-81	5	✓	✓
New Canal Street	SB	49 SB	188	3	191	135	10	145	-23.9%	-46	4	✓	✓
Park Street	SB	65 SB	866	35	901	856	71	927	2.9%	26	1	✓	✓
A4540 north of Camp Hill Circus Junction	NB	72A NB	1028	159	1187	1035	163	1198	0.9%	11	0	✓	✓
A4540	SB	72B SB	1048	144	1192	1061	156	1217	2.1%	25	1	✓	✓
Fazeley Street	EB	79 EB	191	21	212	179	18	198	-6.7%	-14	1	✓	✓
A45 south of Bordesley Circus Junction	NB	81 NB	876	142	1018	877	142	1020	0.1%	2	0	✓	✓
A45 south of Bordesley Circus Junction	SB	81 SB	981	166	1147	979	166	1145	-0.2%	-2	0	✓	✓
A4540 Dartmouth Middleway	NB		1312	262	1574	1308	261	1569	-0.3%	-5	0	✓	✓
A4540	SB	84 SB	1160	232	1392	1167	231	1398	0.4%	6	0	✓	✓
A47 east of Ashted Circus Junction A47/A4540	EB	85 EB	410	94	505	410	98	508	0.7%	3	0	✓	✓
A47 east of Ashted Circus Junction A47/A4540	WB	85 WB	424	88	511	423	104	527	3.1%	16	1	✓	✓

Appendix C

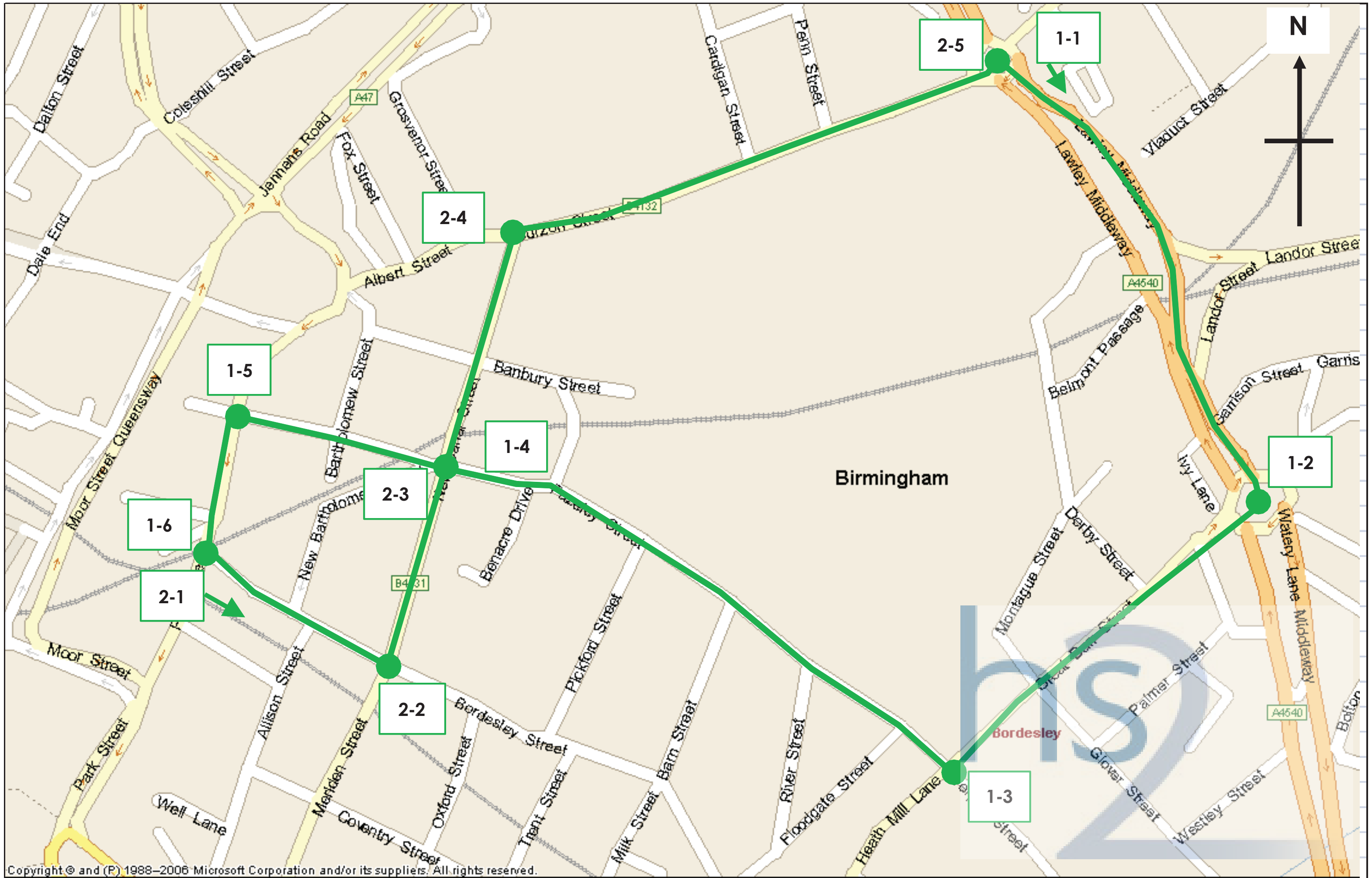
Journey Time Routes



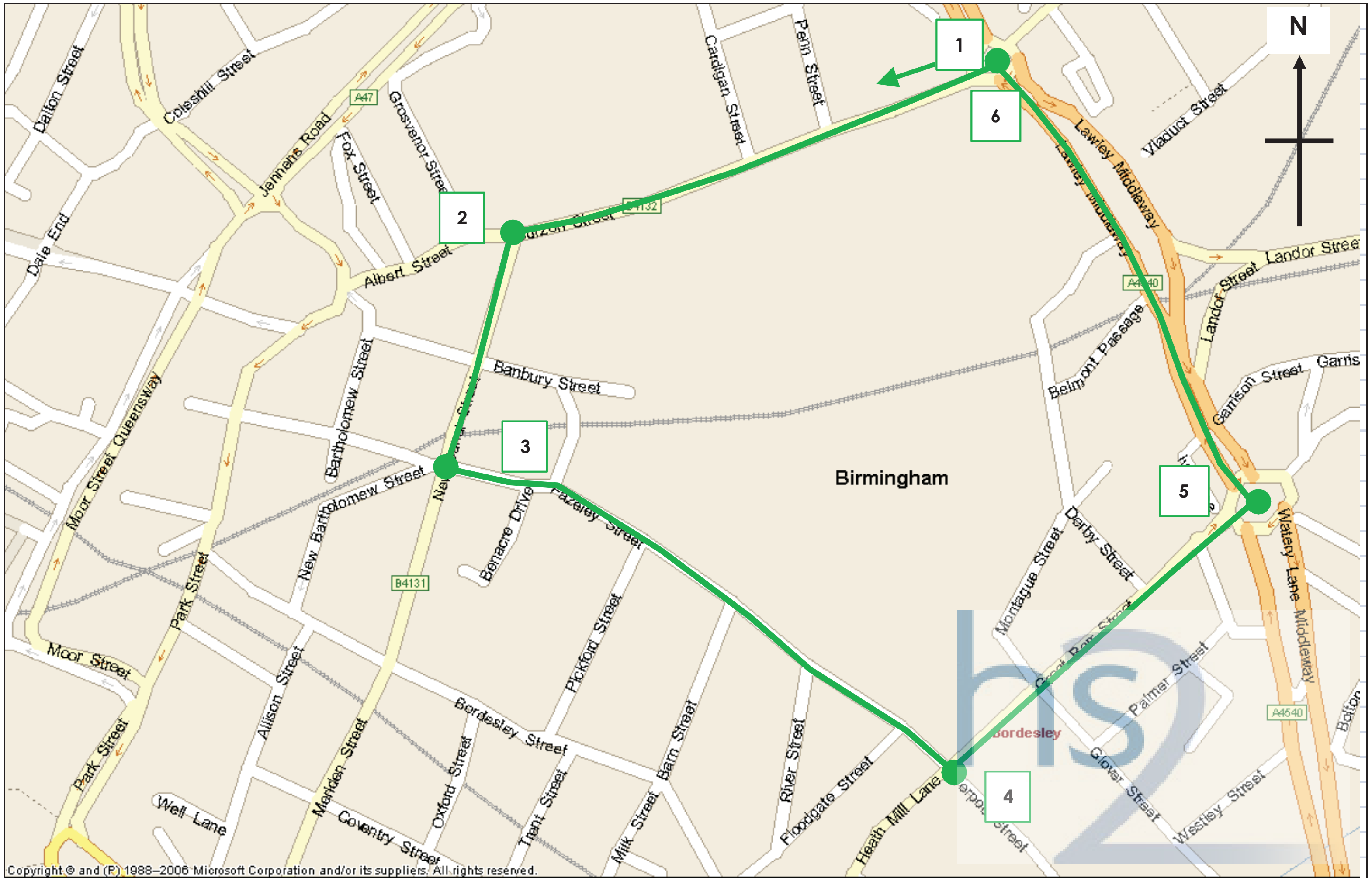
NDC NATIONWIDE DATA COLLECTION	Site / Location:	Blue Route - Clockwise	Project No:	2112	Drawing No:	2112-01	Drawn By: NT
	Survey Date:	June 2012	Project Name:	West Midlands HS2			
	Survey Times:	07:00 to 10:00 & 16:00 to 19:00	Drawing Title:	Timing Points			



NDC NATIONWIDE DATA COLLECTION	**Site / Location:**	Blue Route - Anticlockwise	**Project No:**	2112	**Drawing No:**	2112-01	**Drawn By:** NT
	Survey Date:	June 2012	**Project Name:**	West Midlands HS2			
	Survey Times:	07:00 to 10:00 & 16:00 to 19:00	**Drawing Title:**	Timing Points			

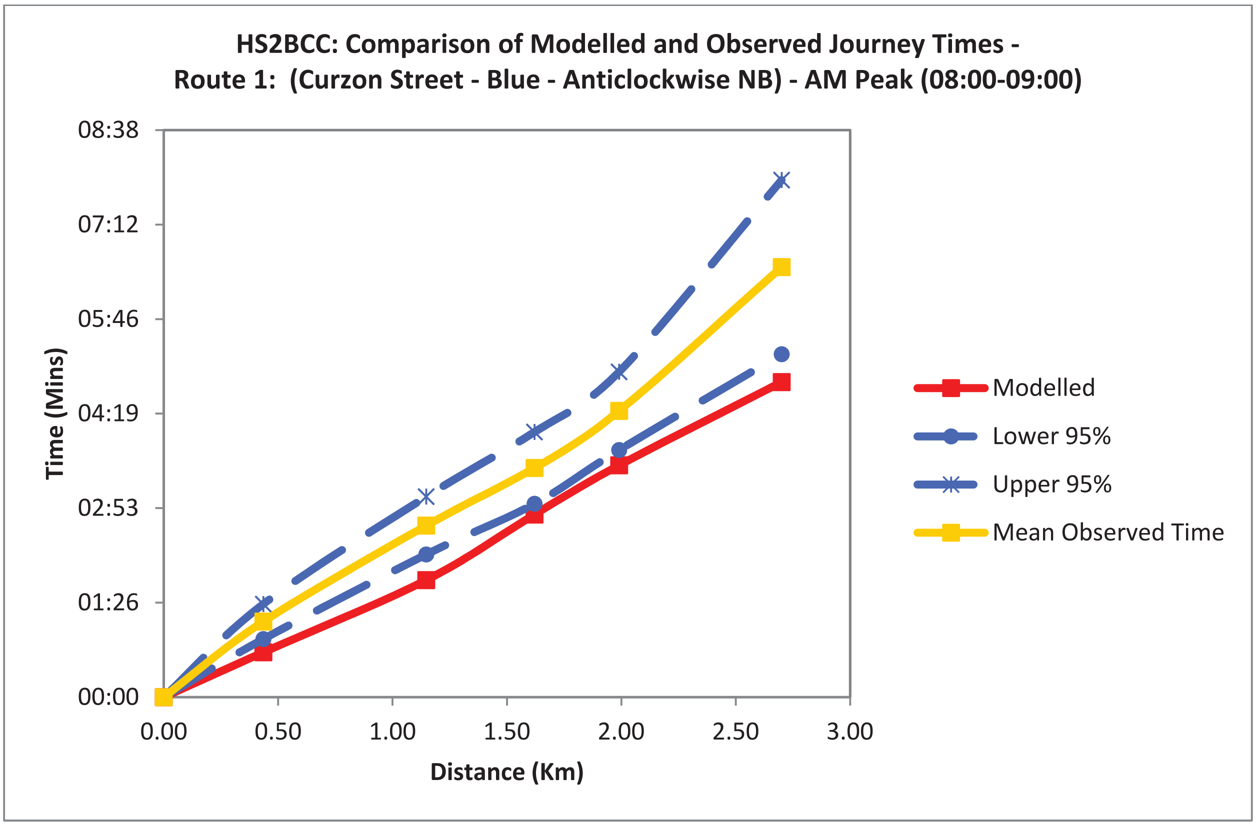


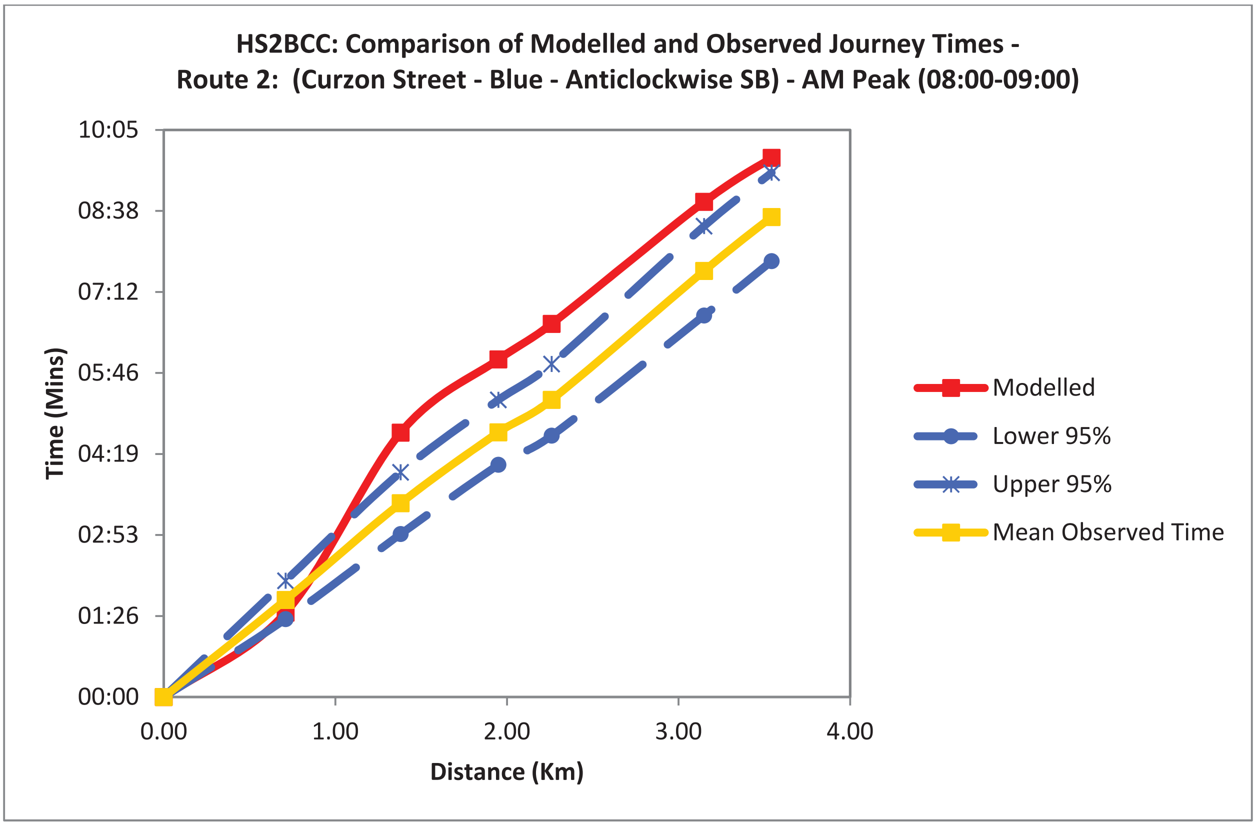
NDC NATIONWIDE DATA COLLECTION	Site / Location:	Blue Route - Clockwise	Project No:	2112	Drawing No:	2112-01	Drawn By: NT
	Survey Date:	June 2012	Project Name:	West Midlands HS2			
	Survey Times:	07:00 to 10:00 & 16:00 to 19:00	Drawing Title:	Timing Points			

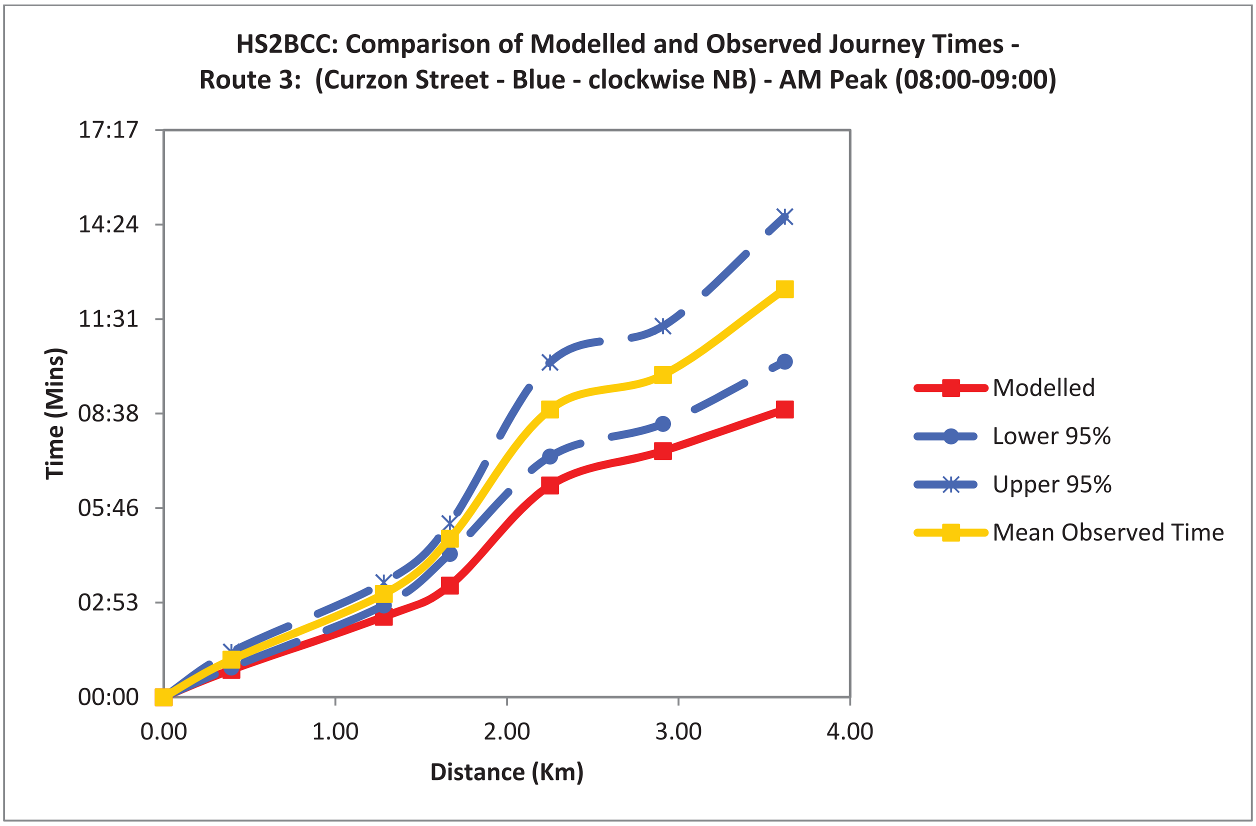


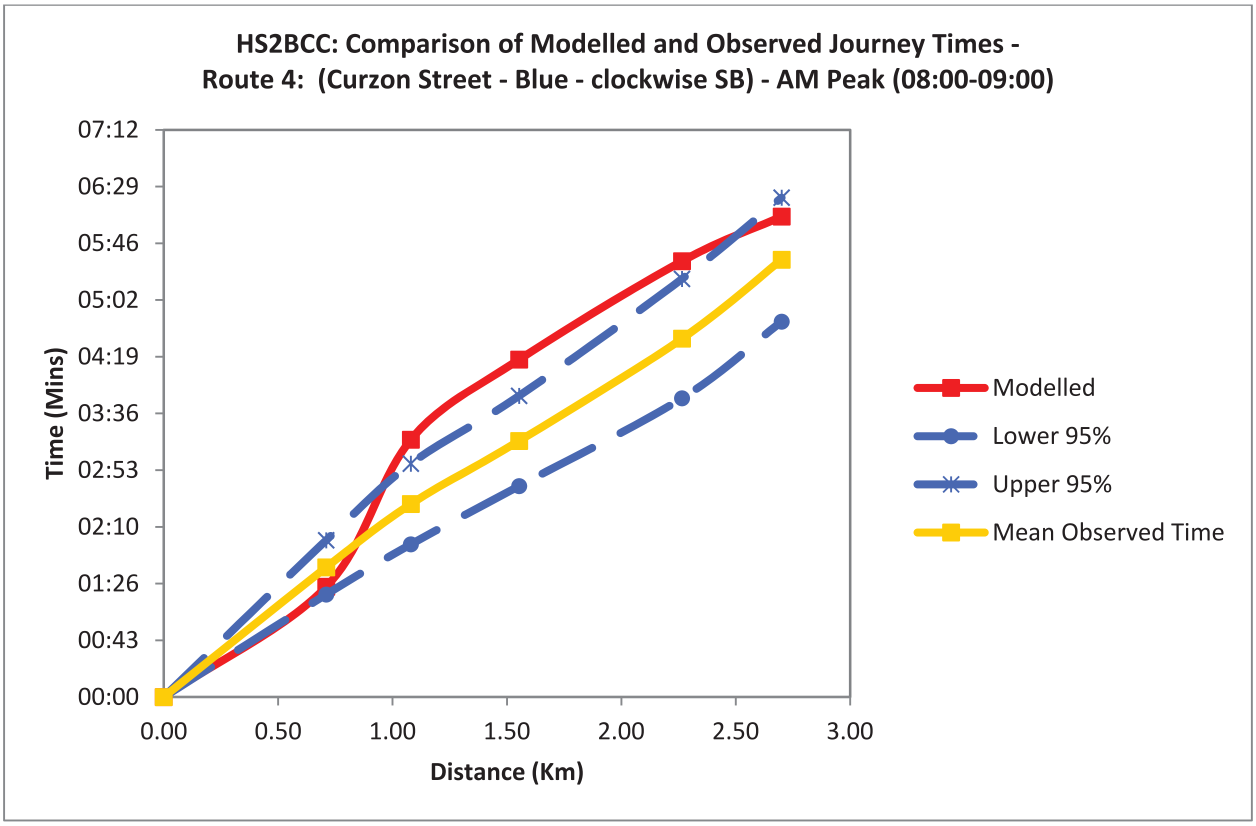
NDC NATIONWIDE DATA COLLECTION	**Site / Location:**	Green Route - Anti clockwise	**Project No:**	2112	**Drawing No:**	2112-01	**Drawn By:** NT
	Survey Date:	June 2012	**Project Name:**	West Midlands HS2			
	Survey Times:	07:00 to 10:00 & 16:00 to 19:00	**Drawing Title:**	Timing Points			

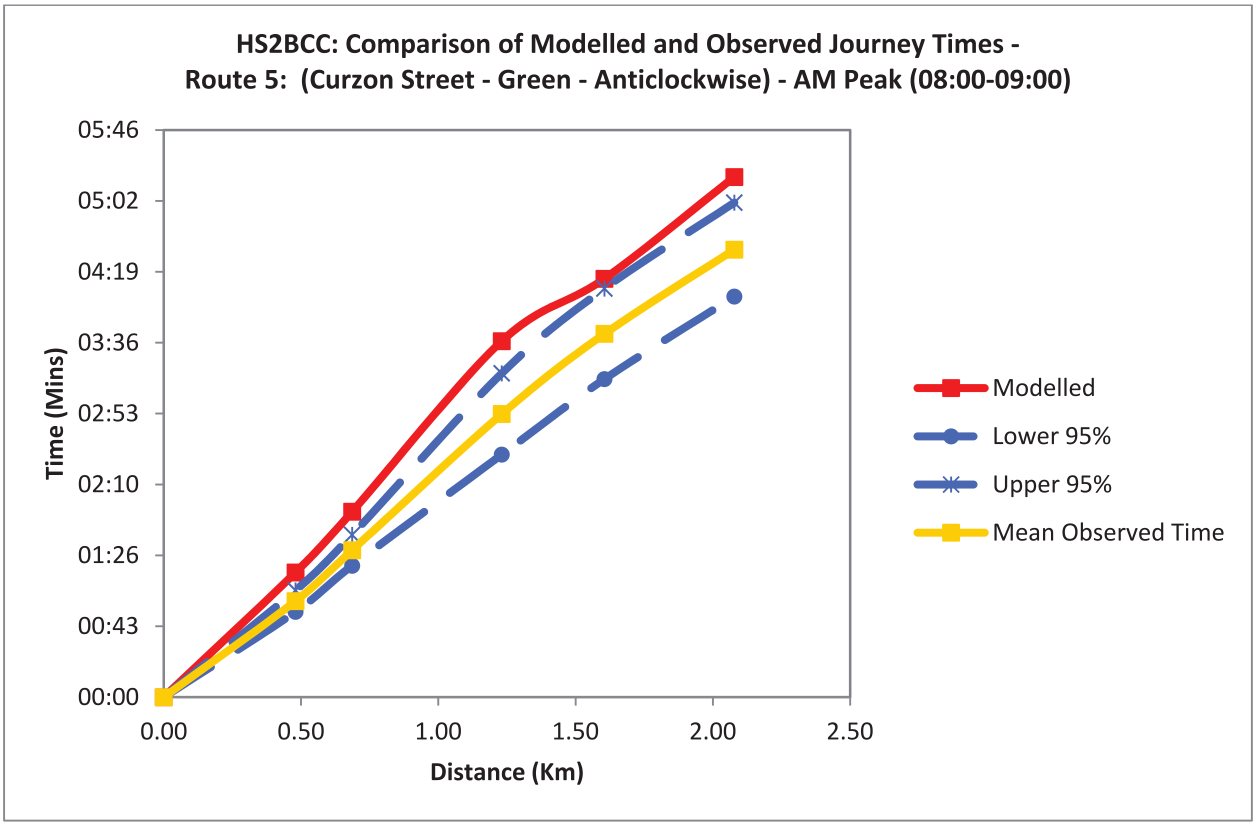
AM Peak Journey Times

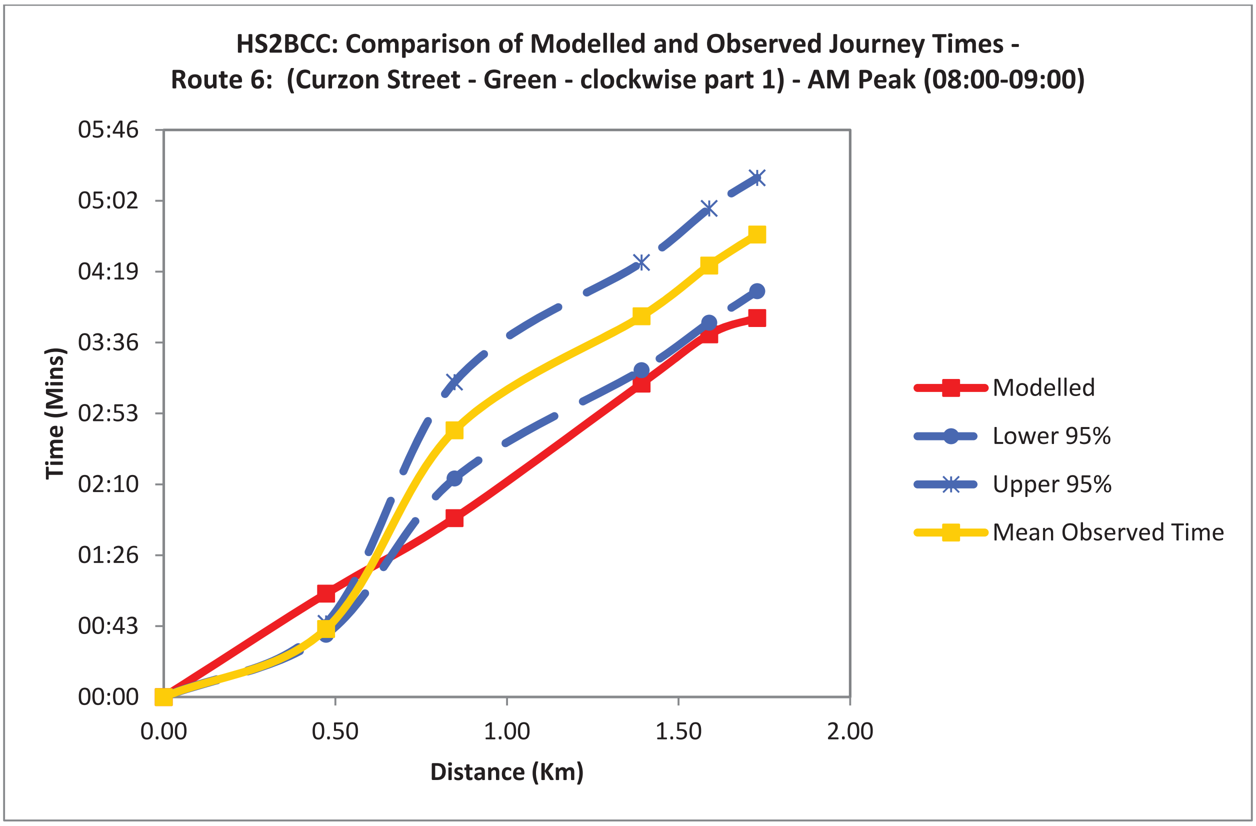


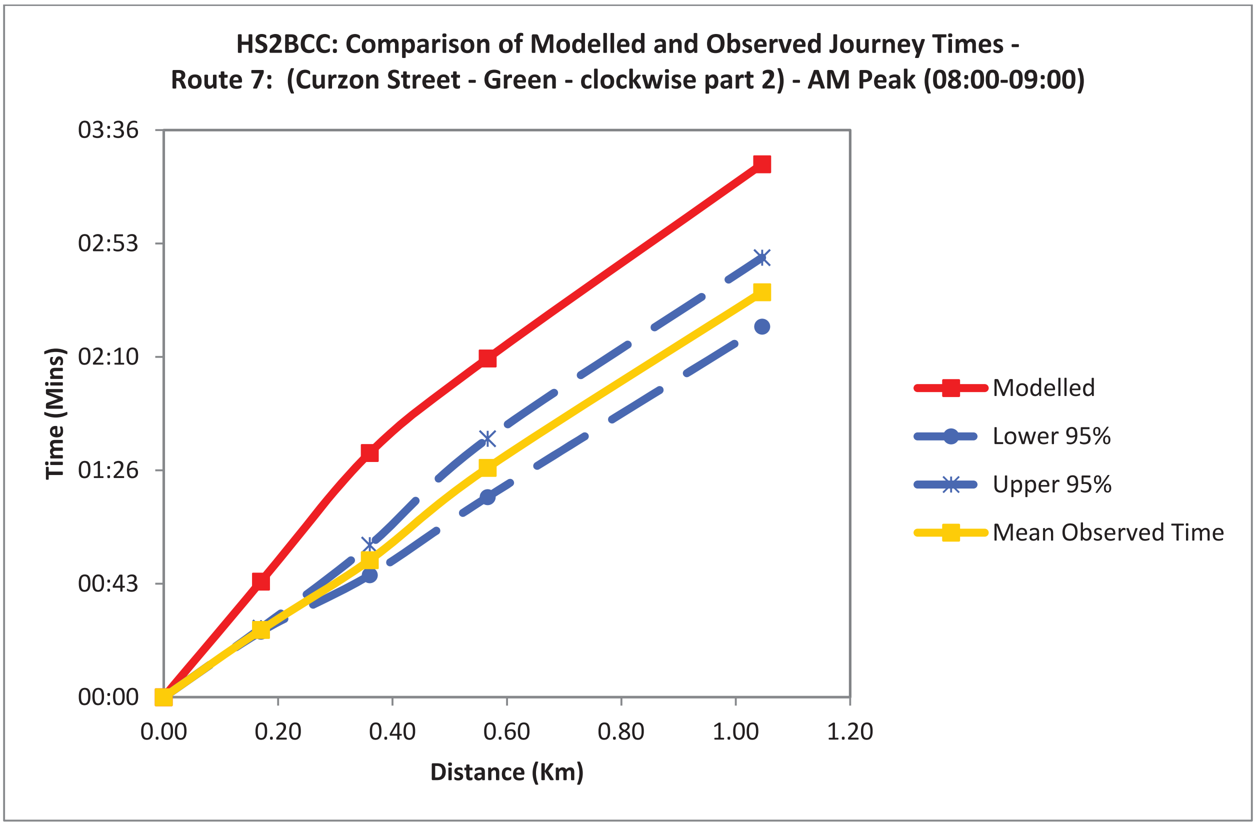



HS2BCC: Comparison of Modelled and Observed Journey Times -
Route 3: (Curzon Street - Blue - clockwise NB) - AM Peak (08:00-09:00)
17:17
14:24
11:31
08:38
05:46
02:53
00:00
Time (Mins)
0.00
1.00
2.00
3.00
4.00
Distance (Km)
Modelled
Lower 95%
Upper 95%
Mean Observed Time

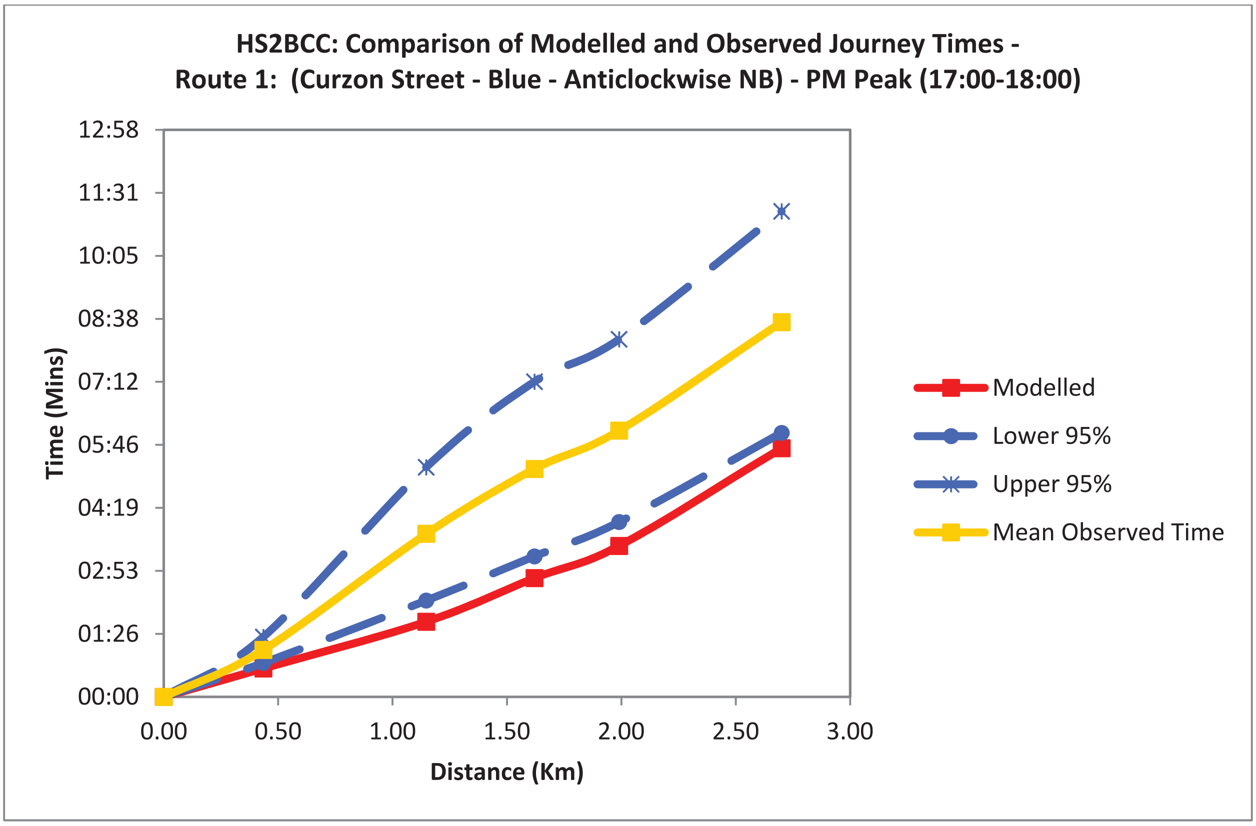

HS2BCC: Comparison of Modelled and Observed Journey Times -
Route 4: (Curzon Street - Blue - clockwise SB) - AM Peak (08:00-09:00)
07:12
06:29
05:46
05:02
04:19
03:36
02:53
02:10
01:26
00:43
00:00
Time (Mins)
0.00
0.50
1.00
1.50
2.00
2.50
3.00
Distance (Km)
Modelled
Lower 95%
Upper 95%
Mean Observed Time

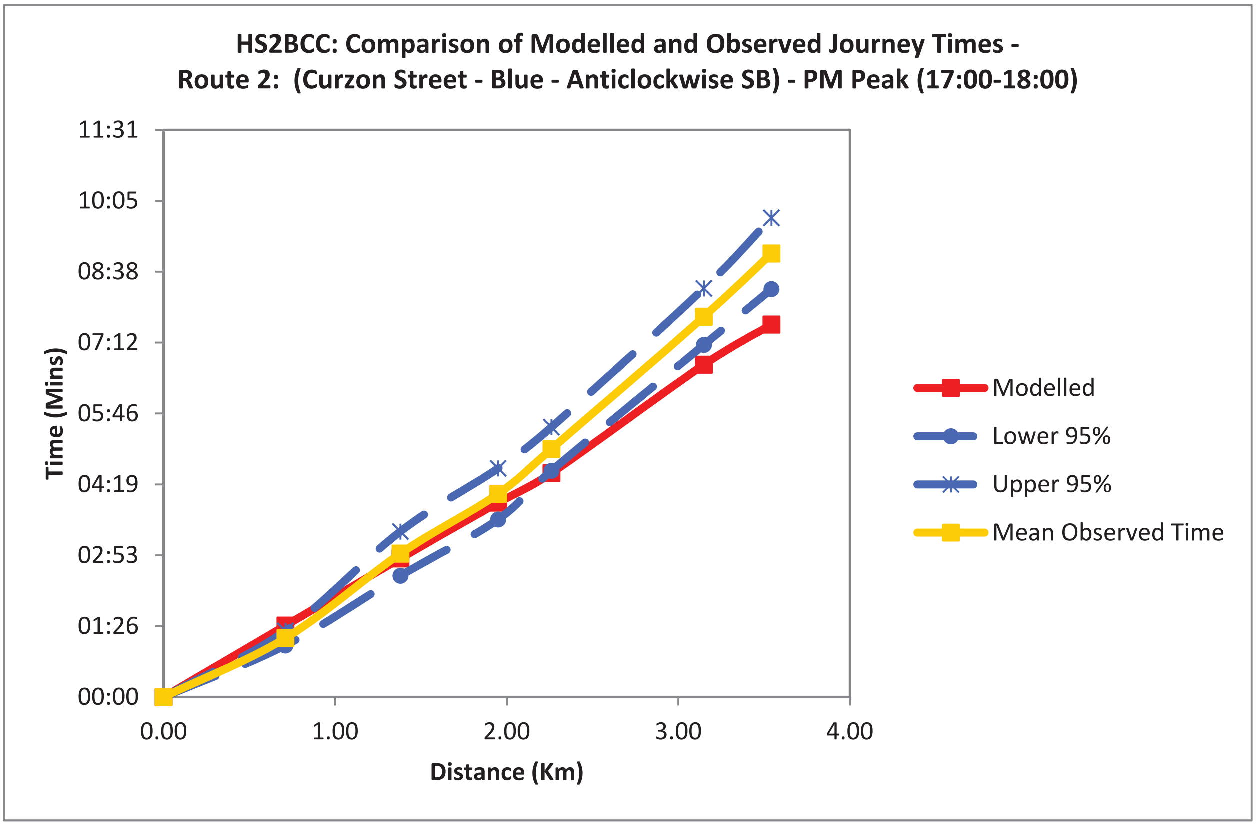

HS2BCC: Comparison of Modelled and Observed Journey Times -
Route 5: (Curzon Street - Green - Anticlockwise) - AM Peak (08:00-09:00)
Time (Mins)
05:46
05:02
04:19
03:36
02:53
02:10
01:26
00:43
00:00
0.00
0.50
1.00
1.50
2.00
2.50
Distance (Km)
Modelled
Lower 95%
Upper 95%
Mean Observed Time

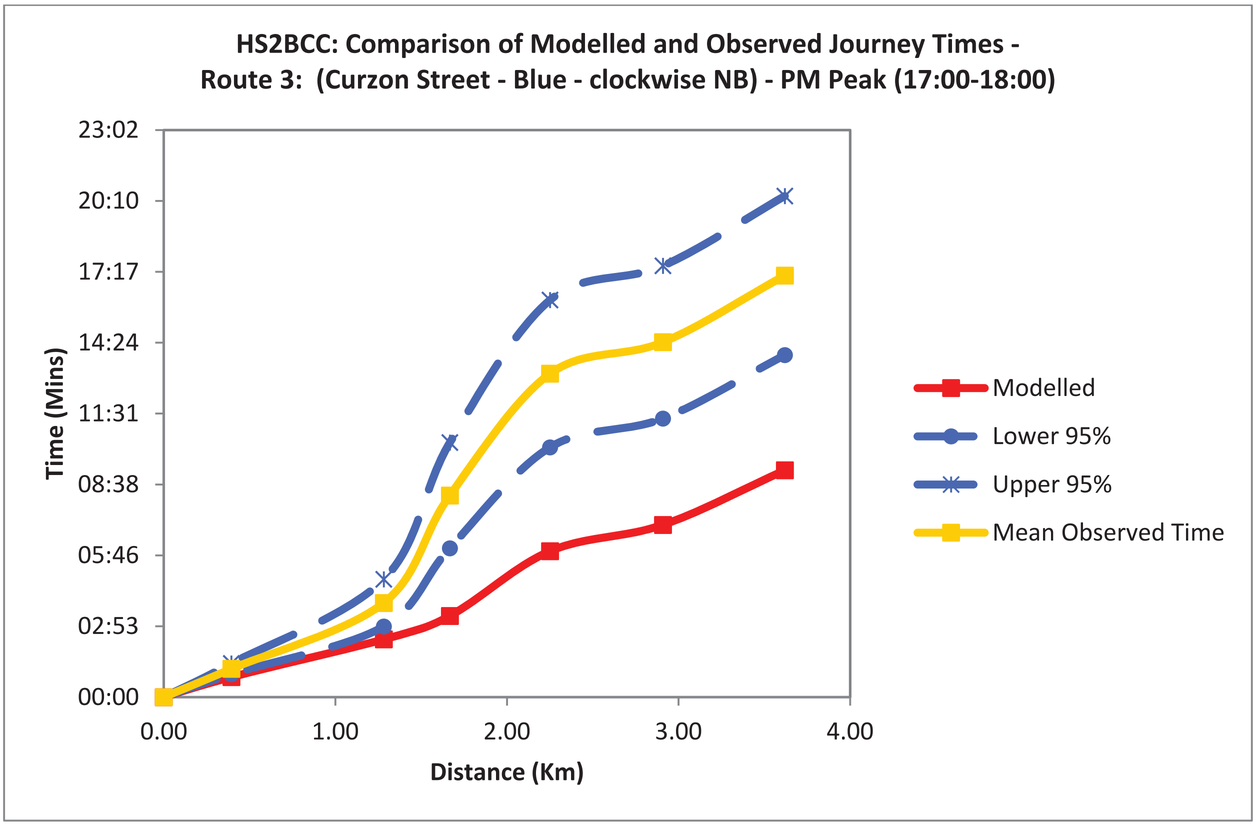

HS2BCC: Comparison of Modelled and Observed Journey Times -
Route 6: (Curzon Street - Green - clockwise part 1) - AM Peak (08:00-09:00)
Time (Mins)
05:46
05:02
04:19
03:36
02:53
02:10
01:26
00:43
00:00
0.00
0.50
1.00
1.50
2.00
Distance (Km)
Modelled
Lower 95%
Upper 95%
Mean Observed Time

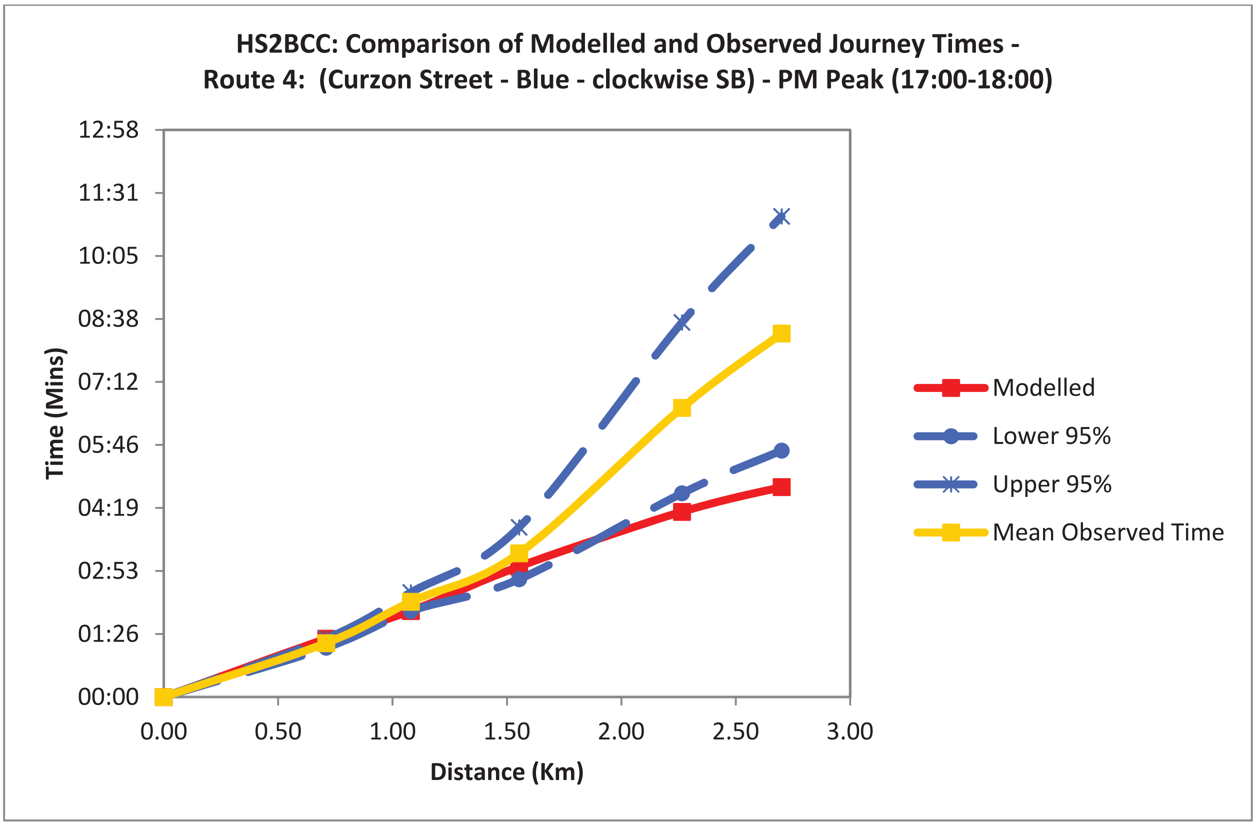

HS2BCC: Comparison of Modelled and Observed Journey Times -
Route 7: (Curzon Street - Green - clockwise part 2) - AM Peak (08:00-09:00)
Time (Mins)
03:36
02:53
02:10
01:26
00:43
00:00
0.00
0.20
0.40
0.60
0.80
1.00
1.20
Distance (Km)
Modelled
Lower 95%
Upper 95%
Mean Observed Time

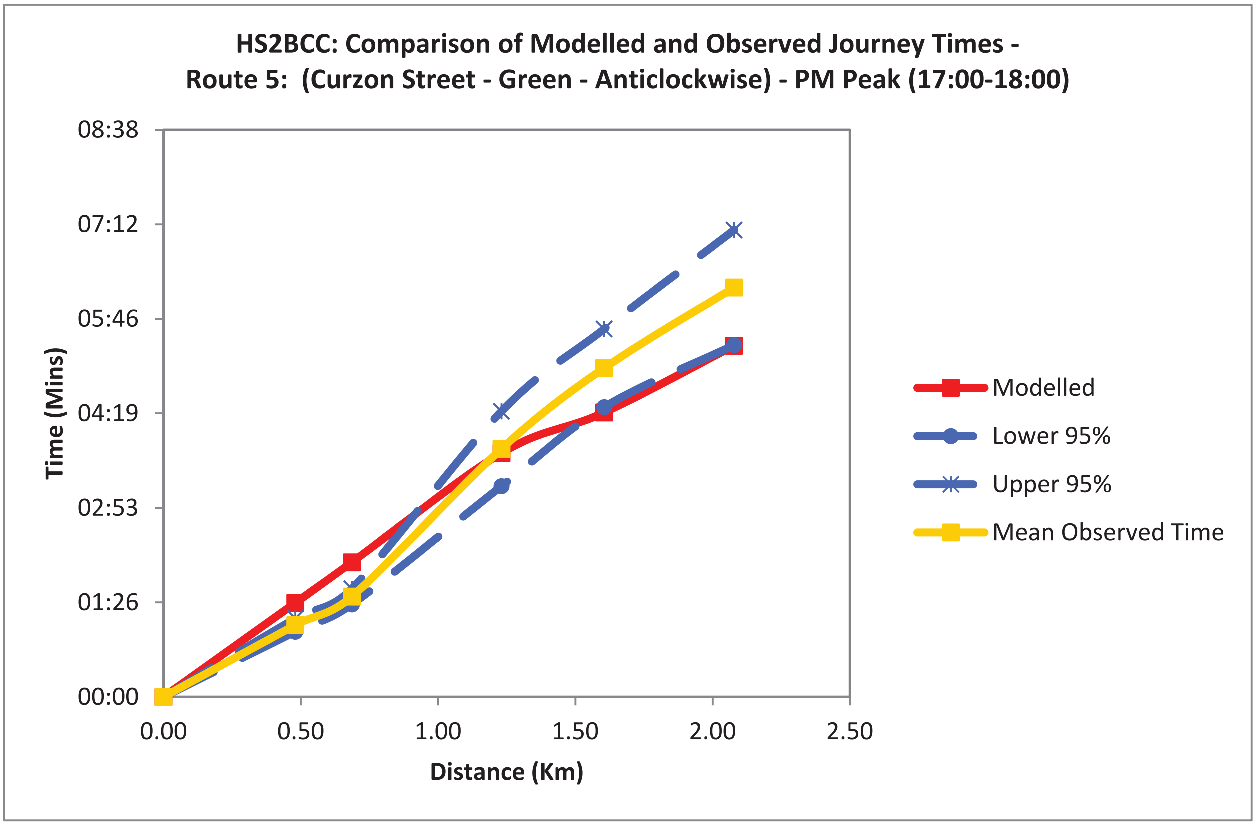
PM Peak Journey Times

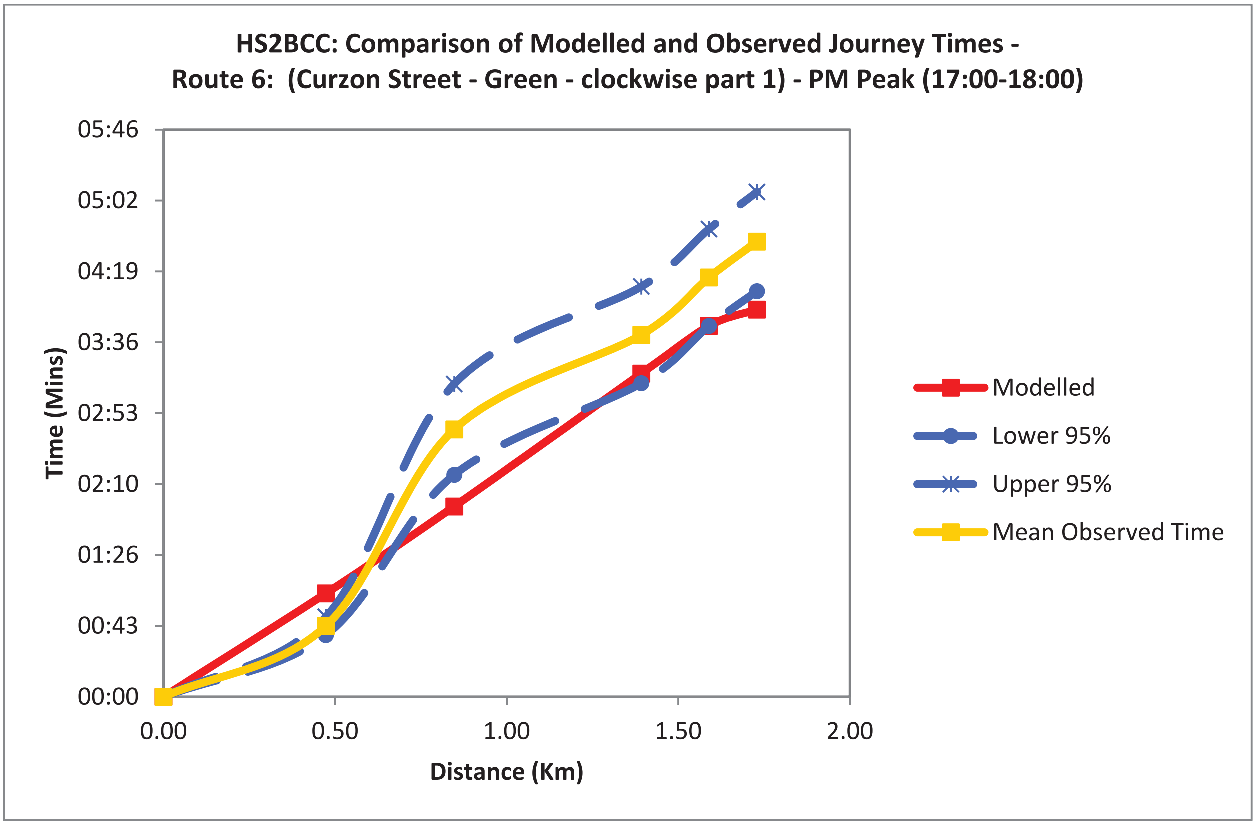


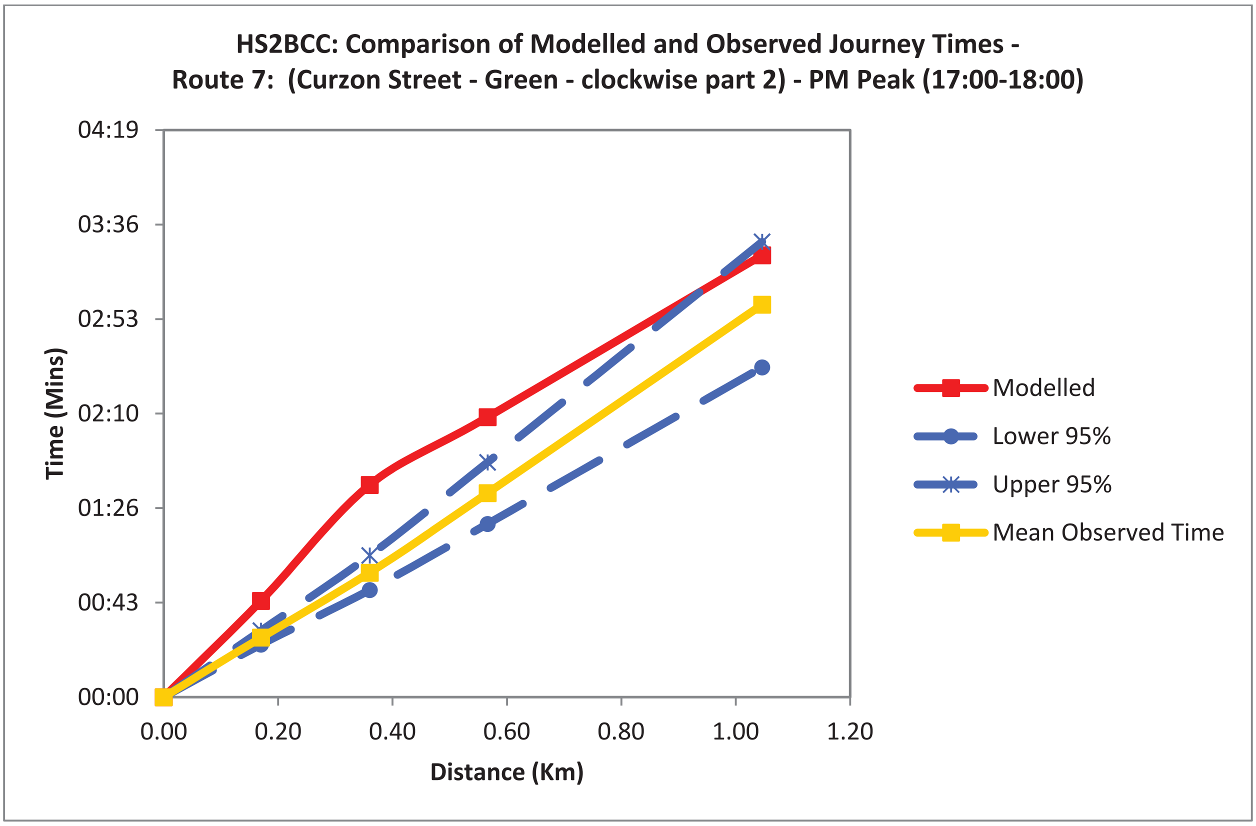



HS2BCC: Comparison of Modelled and Observed Journey Times -
Route 3: (Curzon Street - Blue - clockwise NB) - PM Peak (17:00-18:00)
Time (Mins)
23:02
20:10
17:17
14:24
11:31
08:38
05:46
02:53
00:00
0.00
1.00
2.00
3.00
4.00
Distance (Km)
Modelled
Lower 95%
Upper 95%
Mean Observed Time


HS2BCC: Comparison of Modelled and Observed Journey Times -
Route 4: (Curzon Street - Blue - clockwise SB) - PM Peak (17:00-18:00)
Time (Mins)
12:58
11:31
10:05
08:38
07:12
05:46
04:19
02:53
01:26
00:00
0.00
0.50
1.00
1.50
2.00
2.50
3.00
Distance (Km)
Modelled
Lower 95%
Upper 95%
Mean Observed Time


HS2BCC: Comparison of Modelled and Observed Journey Times -
Route 5: (Curzon Street - Green - Anticlockwise) - PM Peak (17:00-18:00)
Time (Mins)
08:38
07:12
05:46
04:19
02:53
01:26
00:00
0.00
0.50
1.00
1.50
2.00
2.50
Distance (Km)
Modelled
Lower 95%
Upper 95%
Mean Observed Time


HS2BCC: Comparison of Modelled and Observed Journey Times -
Route 6: (Curzon Street - Green - clockwise part 1) - PM Peak (17:00-18:00)
Time (Mins)
05:46
05:02
04:19
03:36
02:53
02:10
01:26
00:43
00:00
0.00
0.50
1.00
1.50
2.00
Distance (Km)
Modelled
Lower 95%
Upper 95%
Mean Observed Time


HS2BCC: Comparison of Modelled and Observed Journey Times -
Route 7: (Curzon Street - Green - clockwise part 2) - PM Peak (17:00-18:00)
Time (Mins)
04:19
03:36
02:53
02:10
01:26
00:43
00:00
0.00
0.20
0.40
0.60
0.80
1.00
1.20
Distance (Km)
Modelled
Lower 95%
Upper 95%
Mean Observed Time